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S. HRG. 101-683

IMPACTS OF PAST URANIUM MINING PRACTICES

HEARING

BEFORE THE

SUBCOMMITTEE ON MINERAL RESOURCES
DEVELOPMENT AND PRODUCTION

OF THE

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

SECOND SESSION

ON THE

IMPACTS OF PAST URANIUM MINING PRACTICES

SHIPROCK, NM, MARCH 13, 1990

Printed for the use of the
Committee on Energy and Natural Resources

U.S. GOVERNMENT PRINTING OFFICE

31-121 WASHINGTON : 1990

For sale by the Superintendent of Documents, Congressional Sales Office
U.S. Government Printing Office, Washington, DC 20402

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IMPACTS OF PAST URANIUM MINING PRACTICES

TUESDAY, MARCH 13, 1990

U.S. SENATE,
SUBCOMMITTEE ON MINERAL RESOURCES
DEVELOPMENT AND PRODUCTION,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Shiprock, NM.

The subcommittee met, pursuant to notice, at 9:13 a.m., in the gymnasium of Shiprock High School, Shiprock, NM, Hon. Jeff Bingaman, presiding.

OPENING STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

Senator BINGAMAN. Good morning. This is a hearing of the Subcommittee on Mineral Resources Development and Production of the Senate Energy and Natural Resources Committee. The purpose of the hearing is to receive testimony on the impact of past uranium mining practices, and, of course, there is no better place to have this type of Oversight Hearing than here in Shiprock.

As many of you are personally aware, the health effects of uranium mining in the fifties and sixties are the single greatest concern of many former uranium miners and their family and friends.

We have assembled a distinguished group of witnesses who will testify to the problems and the challenges facing uranium miners and the potential remedies being considered by the U.S. Congress.

During the period of 1947 to 1961, the Federal Government controlled all aspects of the production of nuclear fuel. One of these aspects was the mining of uranium in New Mexico and Colorado, Arizona and Utah. Even though the Federal Government had adequate warning of the hazards involved in uranium mining, these miners, many of whom were Native Americans, were sent into inadequately ventilated mines with virtually no instruction regarding the dangers of ionizing radiation. These individuals had no idea of those dangers, and consequently, many miners inhaled radon particles that eventually yielded substantial doses of ionizing radiation. As a result, these miners have a substantially elevated cancer rate.

During most of these years, the sole purchaser and beneficiary of the uranium was the U.S. Government for its nuclear testing program.

The U.S. Public Health Service conducted studies of Navajo miners from 1949 through the 1960s to assess the dangers of radi-

ation exposure. By 1951, the Public Health Service and the Atomic Energy Commission were aware of the hazards and knew much about how to alleviate the problem.

It was not until mid-1971, however, that the Federal Government established and fully implemented mine safety standards. Lung cancer and other serious respiratory diseases previously unknown to Navajos became prominent among Navajo miners. As the Public Health Service study and many subsequent studies have found, the injuries suffered by uranium miners were caused by radiation and radioactive dust particles.

So far, affected miners have gone largely uncompensated. Due to a lack of access to legal advice, most miners have been unable to obtain benefits under the state workmen's compensation laws. For many, the statute of limitations had expired before they became aware of those remedies.

About 200 Navajo uranium miners attempted to sue the Federal Government in 1979 to obtain compensation for their injuries. The Arizona Federal District Court ruled that the Federal Government was immune from liability under the doctrine of sovereign immunity. The Appeals Court concurred with that lower court's decision. However, both courts agreed that this is the type of case that cries out for redress, but the courts are not able to give it; Congress is the appropriate source.

Congress is taking action to provide that redress. Legislation is moving forward in Congress to address the needs of uranium miners, as well as the victims of exposure to atmospheric nuclear testing. The legislation would create a compensation program to make compassionate payments to these victims.

I am pleased to be a cosponsor of Senator Hatch's legislation in that regard, which has been reported favorably out of the Senate Labor and Human Resources Committee and is ready for consideration by the full Senate.

I look forward to the testimony of our witnesses today, who are eminently qualified to address the concerns of uranium miners and their families.

Let me point out at this point that Senator Domenici will be joining me at the hearing and is expected momentarily. He has taken a great interest in these issues and has been involved in them for over a decade, having introduced legislation himself on this issue in 1979 and 1980.

Before we begin, there are a few administrative details that I need to mention. Given the large number of witnesses today, we need to be sure that every one of those witnesses has the opportunity to be heard. So we have asked the witnesses to summarize their statements within three to five minutes and include their entire written statement in the record.

I know there are many people in the audience who have opinions and would like to share those opinions with the Committee and the Congress. Unfortunately, we do not have time to hear from everyone who might want to speak. And in an effort to accommodate those, we would like to take statements for the record.

The official hearing record will remain open for two weeks following this hearing today. We also will be having, after this hearing is concluded, an opportunity for individuals in the audience to

ask questions and visit with some of the witnesses, who have agreed to stay and respond to those questions.

We will be calling the witnesses in two panels. Before I call the witnesses, I would like an opportunity for some of what I have said to be translated, so that it is clear to everybody what our procedures are going to be here and the purpose of the hearing.

Mr. CHARLEY. Thank you, Mr. Senator.

[Senator Bingaman's remarks translated in Navajo language.]

Senator BINGAMAN. Thank you very much. Before we go to our panel, let me now call upon Senator Domenici, who has been active on this issue for a great many years and introduced legislation on it sometime ago, as I mentioned before, and call on him to make any opening statement that he would like to.

STATEMENT OF HON. PETE V. DOMENICI, U.S. SENATOR FROM NEW MEXICO

Senator DOMENICI. Thank you very much, Mr. Chairman. Let me first apologize to you and the people here for being late. Even though these are very modern times, I might say, Mr. Chairman, the computer that controls the traffic tower in Albuquerque broke down at about 8:00. I was 30 minutes there on the ground waiting for them to fix the computer. So I got here as soon as I could.

I have a rather detailed statement that outlines the history of this problem and my involvement since about 1978. I would ask that it be made a part of the record.

Senator BINGAMAN. We will include that as part of our official record.

Senator DOMENICI. Let me just say, since we are short of time today and many people want to be heard, suffice it to say that I am pleased to be a cosponsor of this legislation. I think we have now found a way, under the leadership of Senator Hatch and Senator Kennedy, to, as a nation, provide some reasonable compensation to those who were injured, who, most probably, suffered from cancer and related disease as a result of the lack of appropriate regulations dating back before 1971 in the uranium mines in the U.S. and, in particular, in New Mexico.

I am very hopeful that today's hearing will yield broad support for this legislation, so that we can get on with passing it in the Senate. We will never be able to make up for what occurred in those early years of uranium mining here in New Mexico and in the U.S., but this, at least, is an acknowledgment of a serious shortcoming on the part of the national government and the Atomic Energy Commission back in those days, and I think it is high time we get it done.

I thank you, Mr. Chairman, for calling the hearing here in Shiprock. I hope everyone understands that we are going to try our very best to pass this quickly, and, as I said, there may be other ways to do it, but we have all tried other ways, and we ought to get this one done, and there will be some reasonable compensation and a strong acknowledgment of shortcomings on the Nation's part. Thank you very much.

[The prepared statement of Senator Domenici follows:]

STATEMENT OF SENATOR PETE V. DOMENICI

ON

IMPACTS OF PAST URANIUM MINING PRACTICES

SUBCOMMITTEE ON MINERAL RESOURCES DEVELOPMENT AND PRODUCTION

COMMITTEE ON ENERGY AND NATURAL RESOURCES

UNITED STATES SENATE

SHIPROCK, NEW MEXICO

MARCH 13, 1990

Mr. Chairman, I want to thank you for coming to Shiprock to discuss the health problems of the individuals who worked in the uranium mines from the 1940s to the 1970s.

For the past 12 years I have sought to obtain compensation for these uranium miners. I became involved in this issue when the problem of lung cancer among uranium miners was brought to my attention by the Navajo Nation, many of whose members worked in the uranium mines of the Southwest.

Although mine conditions improved greatly after Federal regulation of the mines was imposed in 1971, many miners who worked in the uranium mines prior to that time were exposed to unacceptably high levels of radiation in the mines.

As I looked into the issue, I discovered that many uranium miners, both Indian and non-Indian, suffered from lung cancer and other illnesses that could be related to their exposure to radiation in the uranium mines.

Mr. Chairman, the United States Government has an obligation to provide compensation to the uranium miners. During the time that these miners worked in the uranium mines, the United States Government was the sole purchaser of uranium in this country. In effect, the miners were producing uranium for the United States Government.

The United States Government has a special obligation to provide compensation to Navajo uranium miners. This obligation arises from the trust relationship between the United States Goverment and the Indian people. Under this trust relationship, the United States Government has a special duty of care to protect Native Americans and provide for their health care.

The uranium miners performed a service for our Nation. Now many of them have become ill because of that service. It is now time for the United States Government to perform a service for the miners.

In 1978, I introduced the Uranium Miners Compensation Act, the first bill to attempt to provide compensation for uranium miners who contracted radiation-related illnesses. This bill was S. 3199 in the 95th Congress.

Statement of Senator Domenici
Page Two

S. 3199 would have created a presumption that miners afflicted with lung cancer after 10 or more years in the mines contracted the disease as a result of their employment in the mines. It would have required miners to first seek workers compensation for claims for benefits for death or total disability due to lung disease as a result of employment in a uranium mine. In States with workers compensation systems that provided inadequate coverage for uranium miners, the mine operators would have had to purchase insurance to provide benefits to their miners.

In August 1979, I held a field hearing in Grants on the health problems of uranium miners.

The next month, I introduced a revised version of the Uranium Miners Compensation Act. This bill was S. 1827 in the 96th Congress.

S. 1827 would have provided compensation and medical benefits through the Social Security Administration to uranium miners who worked for 3 years or more in the mines prior to the implementation of Federal regulation of the mines in mid-1971 and who contracted lung cancer, broncial cancer, lymphatic cancer, pulmonary fibrosis, silicosis, or any other radiation-related illness specified by the Social Security Administration. Survivors of such miners also would have been eligible for benefits.

The bill also would have established a program for the notification of individuals eligible for compensation and medical benefits.

Subsequently, because New Mexico is the birthplace of the atomic bomb and its National Laboratories have long been invloved in the program of developing and testing nuclear weapons, I became interested in attempts to compensate individuals who contracted radiation-related illnesses as a result of the atmospheric atomic testing program of the United States Government.

In 1985, I voted in favor of the Hatch Amendment to the Compact of Free Association with Micronesia. The Hatch Amendment would have established a trust fund for individuals who lived downwind of atmospheric atomic testing sites and who developed radiation-related illnesses.

In 1986, I introduced S. 2898, the Atomic Veterans Relief Act. The bill would have allowed veterans who participated in the atomic testing program and who are entitled to receive medical care for radiation-related diseases also to receive disability compensation for those diseases, unless the Veterans Administration (VA) could demonstrate that the disability was not related to the atomic veteran's exposure to radiation.

S. 2898 also would have allowed the atomic veterans to sue the Federal Government directly for their radiation-related injuries.

In the 100th Congress, I joined with Senator Murkowski in introducing S. 453, the Veterans' Ionizing Radiation Compensation Improvement Act of 1987.

S. 453 would have added three radiation-related diseases to the VA's list of presumptive diseases and would have allowed atomic veterans with those diseases to receive compensation through the existing VA compensation system. It also would have adjusted the radiation exposure estimates that the VA uses in evaluating other radiation-related claims.

S. 453 established the framework for the bill that became P.L. 100-321, the Atomic Veterans Compensation Act, which finally provided compensation to the atomic veterans. P.L. 100-321 provides disability payments through the VA to atomic veterans and survivors' benefits to their families by creating a presumption of service connection for 13 diseases. This means an atomic veteran need only prove that he is, in fact, an atomic veteran and he is at least 10% disabled as a result of one of the 13 diseases in order to obtain disability compensation from the VA for his illness. The VA may deny the claim only if it can prove that the disease is not service connected.

The 13 diseases are leukemia, lymphoma, multiple myeloma, and cancers of the thyroid, breast, pharynx, esophagus, stomach, pancreas, liver, small intestine, gall bladder, and bile duct.

The diseases must manifest themselves within 40 years - 30 years for leukemia - of the date of radiation exposure in order for the veteran to be eligible for benefits.

I strongly supported the enactment of P.L. 100-321 and went to the White House to urge President Reagan to sign the bill.

Soon after the Senate returns from the current recess, the Senate Labor and Human Resources Committee will introduce the National Atmospheric Nuclear Testing Compensation Act, a bill to provide compensation for both uranium miners and downwind victims of the atmospheric atomic testing program. I am a cosponsor of this legislation and will work in the Senate to see that it becomes law this year.

The National Atmospheric Nuclear Testing Compensation Act includes findings that uranium miners were exposed to radiation that produced lung cancer and other respiratory diseases and that the United States Government has a special trust responsibility to provide care and assistance to Native American uranium miners. The bill includes an apology from the Congress to the uranium miners and their families.

Under the bill, a $100 million trust fund would be established to provide compensation. A Special Master in the 10th Circuit would hear claims and award compensation.

Miners, or their beneficiaries, would be entitled to $100,000 in compensation if they: (1) worked in the uranium mines in New Mexico, Arizona, Colorado, or Utah between 1947 and 1971; (2) were exposed to 200 or more working level months of radiation; and (3) contracted lung cancer or another serious respiratory disease.

Individuals who lived downwind of the atmospheric atomic testing sites, or their beneficiaries, would receive $50,000 if they: (1) lived at least 1 year in a downwind area during the times of the atmospheric testing program or lived in the downwind area between June 30 and July 31, 1962; and (2) developed leukemia (except chronic lymphatic leukemia), multiple myeloma, or cancer of the bile duct, breast, colon, esophagus, gall bladder, liver (except where cirrhosis or hepatitis B is present), lung, pancreas, pharynx, small intestine, stomach, thyroid, or urinary tract.

An estimated 1,100 to 1,300 downwinders and 250 to 350 uranium miners or their beneficiaries would receive compensation under this bill.

Mr. Chairman, I support compensation for the uranium miners because they performed a service for our Nation. In the course of that service, a number of them suffered grievous injury. Our government has an obligation to these people, an obligation that it has yet to fulfill. It is time that we recognized that fact and set to work righting the wrong that began over 40 years ago. These men served this nation well, and it time for this nation to serve them well.

Senator BINGAMAN. Thank you very much.

Let me now call upon our first witness, and that is Leonard Haskie, who is the Interim Chairman for the Navajo Tribal Council, Navajo Tribe. And we are very pleased to have him here and look forward very much to his statement. Go right ahead, Leonard.

STATEMENT OF LEONARD HASKIE, INTERIM CHAIRMAN, NAVAJO TRIBAL COUNCIL

Mr. HASKIE. Thank you, Mr. Chairman, Senator Domenici. On behalf of former Navajo uranium miners and the surviving families of deceased miners, I am honored to present the accounts of hardships they are facing as a result of the Federal Government's negligence.

I would like to thank you, Chairman Bingaman, for holding this hearing in Shiprock, New Mexico, Navajo Nation, and giving our people an appearance and support, Senator Domenici. You are one of the original champions of the cause. I also would like to thank the sponsors of the Radiation Exposure Compensation Act, Representative Owens and Senator Hatch, for their decade-long leadership in trying to secure a legislative remedy.

I must express the Tribe's gratitude to several individuals working in the field out here, some of whom will speak today, as well as someone who has been a real hero to our uranium miners.

Stewart Udall was the first to come up to this Chapter and realize that the Navajo uranium miners had valid claims against the Federal Government. Without his selfless involvement, our Navajo miners would not even know their rights. He has persevered for almost 12 years to see justice done, and with his continued help, I think we finally will.

The Navajo Nation extends its gratitude to the U.S. Government for all the assistance it has given on a government-to-government basis. As it is expressed in treaties, agreements, statutes, executive orders, and judicial pronouncements, a trust relationship exists between the Federal Government and Indian tribes.

Sadly, the Federal Government violated its special duty of care to the Navajo uranium miners by failing to warn them and protect them from the hazards of uranium mining. Both the Legislative and Executive branches exercised full responsibility over the management of tribal natural resources and health care of miners during the time Navajos worked in the uranium mines. While Navajo miners proudly made a contribution to the national security interest of this country, they now tragically suffer.

Uranium ore was mined from our lands, from the early 1940s to the late 1960s in four large mining districts: Cameron, Arizona; Monument Valley, Utah; Shiprock, New Mexico; and the eastern Black Mesa, Arizona.

Additionally, Navajo miners worked in numerous uranium mines outside the boundaries of the Navajo Nation within the states of Arizona, New Mexico, Utah and Colorado during the 1970s. The sole purchaser and beneficiary of this radioactive mineral during most of this period was the U.S. Government.

During this mining era, Navajos encountered their first contacts with the American industrial system. The majority of these miners

did not speak English, had no knowledge of radiation or the health hazards associated with uranium mining. In fact, there is no word in the Navajo language which means "radiation."

In 1979, approximately 200 Navajo uranium miners and widows of deceased uranium miners sued the Federal Government, but Federal courts said that the Federal Government was protected from liability. The courts also found, however, that the Federal Government knew of the risks but placed the miners' health secondary to national security.

The U.S. Public Health Service, PHS, which has the ultimate obligation to execute the Federal Government's trust responsibility to administer health care for the Navajos, conducted an initial study to assess the dangers of radiation in 1949. This study, conducted on the Navajo Nation, indicated the miners were exposed to very high radiation and high silicate dust containing an undetermined amount of radiation.

By 1951, the PHS and the Atomic Energy Commission realized that mechanical ventilation of the mines would remove the radon and the dust-borne radon daughters. However, in order to proceed with its study, the PHS decided not to tell miners of the hazards, for fear that many miners would quit, which would interrupt the production of uranium.

By 1959, the PHS study revealed a shocking increase above the number of expected deaths from lung cancer among miners. Instead of warning them, the PHS continued to study them under the pretenses that it had insufficient knowledge to establish exposure standards.

I find it unconscionable that the Federal Government, which has a special trust responsibility to care for the health of Native Americans, knowingly sent these miners to their deaths. Federal mine safety standards were not established until 1966 and were not fully implemented until mid-1971, by which time the damage had already been done to our miners.

Therefore, from the 1940s through mid 1970s, Navajo uranium miners were subjected to extremely hazardous working conditions. Navajos were sent into the mines without any protective clothing, face masks or respirators. Because they did not know of the hazards, they ate their lunches in the mines and drank the water running through the mines.

They also brought radioactive materials out of the mines to build their homes; families were, therefore, also exposed. Health conditions not previously known to Navajos became predominant among the Navajo miners. Serious respiratory diseases such as cancer, silicosis, fibrosis and others became prevalent.

Studies show these diseases are caused by exposure to radiation and radioactive dust particles present in the mines. We understand the Radiation Exposure Compensation Act that is currently being considered by Congress would not compensate the Navajo uranium miners for all of these diseases they are suffering from.

The intent of the Act is to only compensate radiation-caused diseases. Unfortunately, many Navajo uranium miners are suffering from serious respiratory diseases to which radiation was only a contributing factor. These respiratory diseases, however, were caused by the same negligent acts of the Federal Government.

Clearly the Federal Government violated its trust responsibilities. The Navajo miners should be compensated for all serious respiratory diseases. You, the Congress, are the only ones who can redress the wrongs committed by the U.S. Government. Both courts in the *Begay* case stated that, "This is the type of case that cries out for redress, but the courts are not able to give it." Congress is the only entity that would be able to do it.

A compensation program was first proposed by Senator Domenici in the 95th Congress. Hearings were held in 1979 and 1980, before the Senate Judiciary Committee and the Senate Labor and Human Resources Committee. The plight of the miners is a longstanding one; they appeal to you again in 1990.

Mr. Chairman, please be mindful of the realities of our nation. We are, in many respects, a developing nation. The per capita income of our people is approximately $2400 per year, and the unemployment rate is approximately 32 percent. We do not have the resources to compensate and care for these people who have suffered from the negligence of the Federal Government.

Many of these people live in very remote parts of the Reservation where there may be no roads, no electricity, no running water, no sanitation facilities, no telephones and few hospitals from which they may receive treatment. Life for former miners with seriously disabling diseases is difficult, at best.

I appeal to your compassion and sense of justice and ask you to make a compassionate gesture to those whose health was considered secondary to the national security interests of this country. The Navajo Tribal Council and several chapters throughout the Navajo Nation have expressed their feelings by passing resolutions in support of the Radiation Exposure Compensation Act.

We look forward to working with you to make sure it is passed. I thank you for this opportunity, once again. I look forward to a positive response. Thank you.

[The prepared statement of Mr. Haskie follows:]

THE NAVAJO NATION

LEONARD HASKIE
INTERIM CHAIRMAN
THE NAVAJO TRIBAL COUNCIL

IRVING BILLY
INTERIM VICE CHAIRMAN
THE NAVAJO TRIBAL COUNCIL

STATEMENT OF LEONARD HASKIE

INTERIM CHAIRMAN, NAVAJO TRIBAL COUNCIL

TO THE

MINERAL RESOURCES DEVELOPMENT AND PRODUCTION SUBCOMMITTEE

OF THE SENATE ENERGY AND NATURAL RESOURCES COMMITTEE

REGARDING THE IMPACTS OF PAST URANIUM MINING PRACTICES

MARCH 13, 1990

On behalf of former Navajo uranium miners and the surviving families of deceased miners, I am honored to present the accounts of hardships they are facing as a result of the federal government's negligence.

I would like to thank you, Chairman Bingaman, for holding this hearing in Shiprock and giving our people an opportunity to voice their suffering. I appreciate your appearance and support Senator Domenici; you are one of the original champions of the cause. I would also like to thank the sponsors of the Radiation Exposure Compensation Act Representative Owens and Senator Hatch, for their decade-long leadership in trying to secure a legislative remedy. I must express the Tribe's gratitude to several individuals work-

out here in the field, some of whom will speak today, as well as someone who has been a real hero to our uranium miners. Stewart Udall was the first to come up to this chapter and realize that the Navajo uranium miners had valid claims against the federal government; without his selfless involvement, our Navajo miners would not even know their rights. He has persevered for almost twelve years to see justice done and with his continued help, I think we finally will.

The Navajo Nation extends its gratitude to the United States Government for all the assistance it has given on a government-to-government basis. As it is expressed in treaties, agreements, statutes, executive orders, and judicial pronouncements, a trust relationship exists between the federal government and Indian tribes.

Sadly, the federal government violated its special duty of care to the Navajo uranium miners by failing to warn them and protect them from the hazards of uranium mining. Both the legislative and executive branches exercised full responsibility over the management of tribal natural resources and health care of miners during the time Navajos worked in the uranium miners. While Navajo miners proudly made a contribution to the national security interests of this country, they now tragically suffer.

Uranium ore was mined from our lands from the early 1940's to the late 1960's on four large mining districts: Cameron, Arizona; Monument Valley, Utah; Shiprock, New Mexico and the

eastern Black Mesa, Arizona. Additionally, Navajo miners worked in numerous uranium mines outside the boundaries of the Navajo Nation within the state of Arizona, New Mexico, Utah and Colorado during the 1970's. The sole purchaser and beneficiary of this radioactive mineral during most of this period was the United States Government.

During this mining era, Navajos encountered their first contacts with the American industrial system. The majority of these miners did not speak or write English and had no knowledge of radiation or the health hazards associated with uranium mining. In fact, there is no word in the Navajo language that means "radiation". For this reason, many Navajo miners did not keep records of their employment or medical problems. While the growth of the nuclear industry brought benefits to the United States Government, tragically, it also resulted in severe health problems and tremendous suffering to the Navajo uranium workers from that time forth.

In 1979 approximately 200 Navajo uranium miners and widows of deceased uranium miners sued the federal government, but federal courts said that the federal government was protected from liability. The courts also found, however, that the federal government knew of the risks but placed the miners' health secondary to national security.

The United States Public Health Service (PHS), which has the ultimate obligation to serve the federal government's

trust responsibility to administer health care for the Navajos, conducted an initial study to assess the dangers of radiation in 1949. This initial PHS study, conducted on the Navajo Nation, indicated the miners were exposed to very high radiation and high silicate dust containing an undetermined amount of radiation.

By 1951 the PHS and the Atomic Energy Commission (AEC) realized that mechanical ventilation of the mines would remove the radon and the dust-borne radon daughters. However, in order to proceed with its study, the PHS decided not to tell miners of the hazards for fear that many miners would quit, which would interrupt the production of uranium. At no time did the PHS undertake the health care of the miners. I find it unconscionable that the federal government, which has a special trust responsibility to care for the health of Native Americans, knowingly sent these miners to their deaths.

By 1959, the PHS study revealed a shocking increase above the number of expected deaths from lung cancer among miners. PHS realized it was watching a group of Navajo uranium miners who were virtually certain to die or suffer disabling lung diseases. Instead of warning them, the PHS continued studying them on the pretense that it had insufficient knowledge to establish exposure standards.

During this mining era, the AEC had the knowledge, funds and power to ensure miners were protected from mining dangers. However, rather than imposing burdens on mining companies or alarming miners, and potentially slowing production, it kept the hazards a secret. Therefore, it left regulation with the states. This is most significant in the case of uranium mines on the Navajo reservation because states had no legal authority to regulate mines on the reservation. Federal mine safety standards were not established until 1966 and were not fully implemented until mid-1971, by which time the damage had already been done to our miners.

Therefore, from the 1940's through mid-1971, Navajo uranium miners were subjected to extremely hazardous working conditions. Navajos were sent into the mines without any protective clothing, face masks or respirators. Because they did not know of the hazards, they ate their lunches in the mines and drank the water running through the mines. They also brought radioactive materials out of the mines to build their homes. They went home from the mines with dust on their clothes. Families were therefore also exposed. Families continue to be exposed because many mines are still open. Children play in them. Tailings blow into the towns that are near to them. The tailings and the sick miners represent the debris the mining age has left.

Health conditions not previously known to Navajos became predominant among the Navajo miners. Serious respiratory diseases such as fibrosis, silicosis, pneumoconiosis and others became prevalent. Studies show these diseases are caused by exposure to radiation and radioactive dust particles present in the mines.

We understand the Radiation Exposure Compensation Act that is currently being considered by Congress would not compensate the Navajo uranium miners for all of these diseases, but we believe that it should. The intent of the Act is to only compensate radiation caused diseases. Unfortunately, many Navajo uranium miners are suffering from serious respiratory diseases (silicosis and pneumoconiosis) to which radiation was a contributing factor, but not the sole cause. These respiratory diseases, however, were caused by the same negligent acts of the federal government. Clearly the federal government violated its trust responsibilities. The Navajo miners should be compensated for all serious respiratory diseases.

We would also like to urge you, the Congress, to make determinations of what injuries the miners sustained as a consequence of their employment in the mines and direct whomever administers the program that such compensable diseases carry irrebuttable presumptions of causation. The bill reported by the Senate Labor Committee directs the Secretary of

Health and Human Services to determine which diseases would be compensable. Again, we urge you, the Congress to make these determinations.

We also ask that the administrators of this compassionate scheme be directed to review with liberality the claims of the Native Americans. The Navajo uranium miners lived primarily in remote areas where available medical care often did not include access to pulmonary specialists. Consequently, diagnoses as recorded on their scare records are often ambiguous. Because the intent of this legislation is to be compassionate, again we urge that the administrators of the scheme be directed to be comprehensive, to err on the side of being over inclusive, when reviewing the claims of Native Americans.

You, the Congress, are the only ones who can redress the wrongs committed by the United States government. Both courts in the Begay case stated that "this is the type of case that cries out for redress, but the courts are not able to give it; Congress is the appropriate source".

A compensation program was first proposed by Senator Domenici in the 95th Congress. Hearings were held in 1979 and 1980 before the Senate Judiciary Committee and the Senate Labor and Human Resources Committee. The plight of the miners is a long-standing one; they appeal to you again in 1990.

Mr. Chairman, please be mindful of the realities of our Nation. We are, in many respects, a developing nation. The per capita income of our people is approximately $2,400 per year and the unemployment rate is approximately 32 percent. We do not have the resources to compensate and care for these people who have suffered from the negligence of the federal government. Many of these people live in very remote parts of the reservation where there may be no roads, no electricity, no running water, no sanitation facilities, no telephones and few hospitals from which they may receive treatment. Life for former miners with seriously disabling diseases is difficult at best. I appeal to your compassion and sense of justice and ask you to make a compassionate gesture to those whose health was considered secondary to the national security interests of this country.

The Navajo Tribal Council and several chapters have passed resolutions in support of the Radiation Exposure Compensation Act. We look forward to working with you to make sure it is passed.

Senator BINGAMAN. Thank you very much. We appreciate that statement. And before I ask a question of you, I would like to just make one other announcement that I failed to make initially, and that is that Congressman Bill Richardson was invited and wished very much to be here.

Unfortunately, the House of Representatives is not following the same schedule as the Senate this year, and Senator Domenici and I are fortunate that the Senate is in recess this week and we were able to be at this hearing today. Congressman Richardson is required to be in Washington voting in the House of Representatives and could not be here, but he is very concerned about these issues, as I am sure everyone is aware.

Let me just ask one question of you, Chairman Haskie, and that relates to the role of the Tribe. If legislation like this were to pass, if we were able to pass legislation of this type, there is a fairly extensive procedure that the people would go through before they could be compensated, in order to get a determination of the appropriateness of their claim for compensation.

And I just wondered, would you know whether the Tribe would be in a position to assist former miners or families that were faced with that prospect and needed assistance in negotiating that system?

Mr. HASKIE. Mr. Chairman, I thank you for the question. And, as you know, prior to my administration, evidently there has been no attention focused on the legislative initiative. Now that we are beginning to recognize the fruits, hopefully for those people who have been—whose lives have been tarnished, we, the Navajo Tribe, are very interested in promotion of an effort that would allow us to institute all kinds of availability of resources.

First of all, we would like to disseminate the information appropriately to all those who would be entitled to compensatory—I guess benefits, and secondly, we need to educate those individuals not to distort or exaggerate the new legislation, to ensure that we are presenting a message to only those who are eligible under the auspices of the new legislation.

The Navajo Tribe does have community health coordinators who, obviously, will be detailed to provide those details, so we could be able to assure that those people are assisted.

Secondly is that, as you know, the Navajo Nation is always willing to work with senatorial representatives. So we also are interested in doing that, and with any other Federal entities. At the same time, instruction should also be focused on Indian health services, because they are more disciplined in some physical aspects and medical portions of the legislation, to ensure that the legislation is in place and becomes implemented. Thank you.

Senator BINGAMAN. Thank you very much. Let me defer to Senator Domenici, if he has any questions.

Senator DOMENICI. I don't think I have any questions. But let me just say to you, Mr. Chairman—is it still "Mr. Chairman," or is there a new title these days?

Mr. HASKIE. Still "Mr. Chairman."

Senator DOMENICI. Still "Mr. Chairman." I think some day it will be "Mr. President." Is that right?

Mr. HASKIE. That's true.

Senator DOMENICI. Mr. Chairman, let me just say to you, as the spokesman for the Navajo people at this time, in their history—I thank you for your opening statement—I think you have quite appropriately laid out the situation as it truly exists.

The United States of America, acting through the Atomic Energy Commission, prior to 1971, clearly made a terrible mistake, thinking they were operating in the national interest. There can be no doubt that a number of uranium mines, located principally in New Mexico, but also three or four other states, were, indeed, serious health hazards to the Indian people and others who worked in them.

I am pleased to live in a country, on the one hand, that, today, can openly and publicly have representatives of this country say they were wrong. On the other hand, it does not do this great Nation justice to think that we had this situation from the forties through 1971. It should not have been permitted to exist.

We have tried in the past to rectify it, and I thank you for your cooperative spirit and your assistance here and in other situations, since you have been thrust into this position. I think we will get this law passed now. It is not total compensation, but it is a reasonable approach to a very old problem that we could not solve before this.

So we are going to work on our end, and we hope, as you indicated in your answer, you will work on your end to implement it and help us where you can. The problem of identifying in other kinds of activities will not be easy. We will need cooperation from professionals, and we thank you for your appearance here today, and I personally want to thank you for what you have been doing in your efforts on behalf of the Navajo Nation. Thank you, Mr. Chairman.

Senator BINGAMAN. Chairman Haskie.

Mr. HASKIE. Thank you, Senator Domenici. Certainly this radiation legislation will be our priority and will be implemented. So I look forward to working with you, as well.

Senator BINGAMAN. Thank you very much. Let me change our procedure slightly, in the interest of time. The five other panel members on this panel, I am going to call on them to go ahead and give their testimony, summarize their testimony, and we will hear from all five before we ask questions of any of you.

And why don't we start with Dr. Richard Hornung, who is Chief of the Statistical Services Section of the Support Services Branch of the National Institute for Occupational Safety and Health out of Cincinnati, Ohio.

Doctor, thank you for coming all this way. We appreciate your presence and are looking forward to your testimony.

STATEMENT OF DR. RICHARD W. HORNUNG, CHIEF, STATISTICAL SERVICES SECTION, SUPPORT SERVICES BUREAU, DSHEFS, NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Dr. HORNUNG. Thank you, Mr. Chairman. You have my written testimony, so I will take about five minutes to summarize.

I am Dr. Richard Hornung, Chief of the Statistical Services Section with the National Institute for Occupational Safety and Health in Cincinnati. I appreciate this opportunity to report to you

on the health effects associated with exposure to radon decay product in U.S. uranium miners.

As requested, I will begin with a brief history of Federal regulations regarding radiation exposure in the uranium mines.

Because of the reports of high lung cancer mortality among miners of radioactive ores in eastern Europe in the late 19th and early 20th century, the U.S. Public Health Service initiated a study of uranium miners in the Colorado Plateau in 1950. After preliminary measurements indicated that exposures in U.S. uranium mines were as high or even higher than those measured in eastern Europe, representatives of the U.S. Public Health Service in the mid-1950s recommended increased ventilation to reduce exposure to underground miners to approximately one working level, or, equivalently, 12 working level months per year, which was thought at that time to be equivalent to the European recommended standard. This recommendation, however, was not adopted by the Atomic Energy Commission.

In 1970 the Bureau of Mines established 12 WLM per year as the Federal exposure limit for underground mines. And in 1971, the Environmental Protection Agency issued Federal radiation protection guidance for radon decay products, which specified the limit of four WLM per year. This guidance was adopted by the Bureau of Mines in 1976. The Mining Enforcement and Safety Administration, or MESA, formally adopted the current standard of four WLM per year.

MESA's successor, the Mining Safety and Health Administration, or MSHA, is currently considering a reduction of that standard. In 1987, NIOSH recommended to MSHA a new standard of one WLM per year.

Now I will briefly summarize the NIOSH assessment of the health effects attributable to exposure to radon decay product in underground uranium miners. This may give some background as to why we recommended a one WLM standard.

Exposure response relationships between cumulative radon daughter exposure and the risk of lung cancer have been shown in the analysis of the U.S. data, as well as several other studies of mining populations in other countries throughout the world. In the U.S. Study, almost five times the expected number of lung cancers have been observed. This is a relative risk of approximately 4.82. NIOSH has presently identified over 350 lung cancer deaths among the 4146 miners in our study group.

Other causes of death with significantly elevated risks include renal disease, with a relative risk of 2.6; nonmalignant respiratory diseases, with a relative risk of 3.2; and accidents, with a relative risk of 3.3.

In 1986, at the request of the Mining Safety and Health Administration, NIOSH produced a quantitative risk assessment relating the relative risks of lung cancer to measured levels of radon decay products associated with uranium miners in the Colorado Plateau.

In addition to exposure to radon daughters, this risk assessment considered such factors as cigarette smoking, age, years of other types of hard rock mining and time since last exposure in underground uranium mining.

This analysis, as with most other models of radiation carcinogenesis, assumes no threshold for exposure effects. In other words, this means that there is no totally—or no totally safe level of radon exposure is assumed, and that each additional WLM of exposure above naturally occurring background will produce a small increment in lung cancer risk. Therefore, one must speak in terms of acceptable risk, rather than a totally safe level of exposure.

The NIOSH risk assessment estimates that exposure to a current standard of four WLM per year for a working lifetime of up to 30 years of mining, which would result in a cumulative exposure of 120 WLM, would result in more than a doubling of risk in lung cancer, compared to a population unexposed to uranium mining.

In order that your committee be able to make rough estimates of lung cancer risks due to specified levels of exposure, a simplified linear trend in risk can be used for exposures below about 1000 WLM. Below such levels, the relative risk of lung cancer increases approximately 1.2 percent for each WLM of exposure.

A table attached to my written testimony gives the NIOSH estimates of lifetime excess lung cancer risk per 1000 miners exposed to levels between 30 and 120 WLM. This concludes my testimony.

[The prepared statement of Dr. Hornung follows:]

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CENTERS FOR DISEASE CONTROL

Before the

SUBCOMMITTEE ON MINERAL RESOURCES
DEVELOPMENT AND PRODUCTION

COMMITTEE ON ENERGY AND NATURAL RESOURCES

U.S. SENATE

MARCH 13, 1990

I am Dr. Richard W. Hornung, Chief, Statistical Services Section of the Division of Surveillance, Hazard Evaluations and Field Studies of the National Institute of Occupational Safety and Health, CDC. I appreciate this opportunity to report to you on the health effects associated with exposure to radon daughters in U.S. uranium miners. I will begin with a brief history of federal regulations regarding radiation exposure of uranium miners.

Because of reports of high lung cancer mortality among miners of radioactive ore in eastern Europe in the late 19th and early 20th century, the U.S. Public Health Service initiated a study of uranium miners in the Colorado Plateau in 1950. After preliminary measurements indicated that exposures in U.S. uranium mines was as high or higher than those measured in eastern Europe, representatives of the U.S. Public Health Service recommended in 1953 increased ventilation to reduce exposure of miners to 1 working level or 12 working level months per year (WLM), which was at the time thought to approximate the recommended standard in Europe of 100 picocuries of radon gas. This recommendation was not adopted by the Atomic Energy Commission.

In 1970 the Bureau of Mines established 12 WLM per year as the Federal exposure limit for underground mines. In 1971, the Environmental Protection Agency issued Federal radiation protection guidance for radon daughters which specified a limit of 4 WLM per year. In 1976,

the Mining Enforcement and Safety Administration (MESA) also formally adopted the current standard of 4 WLM per year. The Mining Safety and Health Administration (MSHA) is considering a further reduction of this standard. NIOSH recommended to MSHA in a 1987 Criteria Document on exposure to radon progeny [33] a new limit of one WLM per year.

REVIEW OF AVAILABLE DATA DEMONSTRATING HEALTH EFFECTS

In reviewing the epidemiologic data [3] for developing the criteria document, NIOSH identified 5 primary epidemiologic studies of underground mining populations from various countries [6-10]. All 5 of these studies demonstrate a significant increase of lung cancer associated with radon progeny exposure in underground mines. One of these was the United States Public Health Service (USPHS) study of uranium miners, reported in 1971 [6] and more recently in 1981 [11] based on subsequent vital status follow-up and using the same epidemiologic analytic approach. In the more recent report, almost 5 times the number of lung cancers were observed in the white male cohort than what was expected (SMR of 482). Exposure response relationships between cumulative radon exposure and the risk of lung cancer have been reported for these data [6-10,12]. Other causes of death with significantly elevated risks include renal disease (SMR=262), nonmalignant respiratory disease (SMR=324) and accidents (SMR=331). NIOSH continues to study this cohort of miners and has presently identified over 350 lung cancer deaths among the 4146 miners.

Two reports on the USPHS uranium miner population mortality have been released based on studies conducted since the previously mentioned

1981 report and using different, statistically more powerful analytic approaches. One of these studies [13] was available for the NIOSH epidemiologic review. The other report, the NIOSH quantitative risk assessment [4], was not available until after the epidemiologic review was released. The quantitative risk assessment will be discussed in more detail later. Both of these two analytic reports provide the strongest evidence of a significant exposure-response relationship in U.S. miners, persisting after the effects of other potential risk factors are considered.

The NIOSH epidemiologic review addressed the evidence of the potential influence of smoking on the association between radon progeny exposure and lung cancer risk. The elevation of lung cancer risk was found to persist in studies of uranium miners or other hard rock miners where the data permit examination of smoking patterns. Two reports based on two of the 5 primary studies [9,13] were identified as the strongest analyses of the potential influence of smoking: one addressed smoking in the USPHS uranium miner population [13] and the other addressed smoking in Swedish iron ore miners [9]. Each of these reports demonstrated that both the exposure to radon progeny and smoking are associated with lung cancer risk and that the resulting combined risk is greater than the risk from either radon progeny exposure or smoking individually. The results of the NIOSH quantitative risk assessment [4] also support this finding. The interaction is, at least, additive and more likely multiplicative. In other words, cigarette smoking is even more detrimental to miners exposed to radon progeny than to the general population.

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The NIOSH review of epidemiologic data included an evaluation of ten additional studies of mortality patterns of miner populations with potential exposure to radon progeny [14-24] denoted as "secondary studies." This categorization was made because these studies were considered to be subject to greater confounding limitations than the original 5 primary studies and, therefore, they could not serve as the basis for any firm conclusions about the relationship between lung cancer risk and radon progeny exposure. These confounding limitations relate to study design, study population size, exposure records, thoroughness of follow-up, etc. Nonetheless, all of these studies did demonstrate significant excesses of lung cancer and, therefore, provided limited corroborative evidence for the relationships observed in the 5 primary studies.

None of the NIOSH-reviewed primary or secondary studies had complete measurements of radon progeny concentrations. However, the data in the 5 primary studies were sufficient to calculate cumulative exposures for the cohort members. Exposures other than radon progeny are present in these mining environments and their potential contribution to lung cancer risks cannot be ruled out, although none of these other recognized exposures could explain all of the observed results. For instance, gamma radiation is another exposure associated with underground mining. However, leukemia, which is the malignant neoplasm most strongly associated with gamma radiation [25-26], has not been observed in significant excess in the study populations in which it has been evaluated and reported [8,11].

Based on the consistency of significant elevations of lung cancer

risks in the 5 primary studies, the existence of exposure response relationships in these studies, and the absence of any obvious factors which could explain the results in all of these different study populations, NIOSH has concluded that occupational exposure to radon progeny carries a potential risk of inducing lung cancer. Radon progeny should be considered a Category 1 "potential occupational carcinogen" based on the classification set forth and defined in the OSHA Cancer Policy 29 CFR 1990. In addition, exposure to radon progeny among cigarette smokers increases the risk of developing lung cancer above that attributable to cigarette smoking alone.

CONCORDANT ANIMAL DATA

Animal data also demonstrate the carcinogenic effect of exposure to radon progeny. In a series of experiments [27-30] which began in the early 1960's, exposure to radon progeny was found to induce lung cancer in Sprague-Dawley rats. These studies showed that the lung cancer mortality among these experimental animals was directly proportional to the lifetime cumulative exposure to radon progeny through the range of 20 to 14,000 WLM. Thus, these data corroborate the conclusions of the 5 primary epidemiologic studies under experimental conditions which were free of the concomitant exposures which may be present in the mining environment.

NIOSH RISK ASSESSMENT DATA

NIOSH transmitted the results of a quantative risk assessment of lung cancer risk in U.S. miners to MSHA in January 1986 [4] and in a

subsequent publication [31]. This risk assessment analyzed the USPHS uranium miner mortality data with vital status follow-up conducted through the end of 1982. The analysis was based on a proportional hazards model, tested various functional forms, and considered the effects on lung cancer risk by several potential risk factors. These factors included: cumulative exposure, cumulative cigarette smoking, average exposure rate, age at initial exposure, birth year, years of prior hard rock mining, time since last exposure, and others. Age was controlled in the proportional hazards model by using it as the time dimension in the functions. The analyses demonstrated that there was a significant exposure-response relationship between lung cancer risk and cumulative radon progeny exposure ($p<0.001$), as well as with several other variables such as cumulative cigarette smoking.

It is noteworthy that this quantitative risk assessment did not require any substantial extrapolation of the fitted risk assessment model from observed higher exposures to lower exposures of interest. In the USPHS uranium miners cohort, 20% of the cohort members have less than 120 WLM cumulative exposure (lifetime occupational exposure corresponding to the current MSHA standard) and 7% of the cohort members have cumulative exposures of 30 WLM and lower. Analyses considered an annual backgroumd exposure equal to the U.S. average background exposure of 0.2 WLM per year [31] and, in acknowledgment that background exposure near ore-bearing lands may be considerably higher [32], an annual background exposure of twice the national average background, 0.4 WLM per year.

Corroborating research findings already discussed, the NIOSH risk

assessment estimated that exposure to radon daughters has an effect upon risk of lung cancer, independent of the risk associated with cigarette smoking. In addition, the effect on lung cancer risk of the combination of radon daughter exposure and cigarette smoking was estimated as nearly multiplicative.

The NIOSH risk assessment, as with most other models of human carcinogenesis, assumes no threshold of exposure. This means that no "safe" level of radon daughter exposure is assumed and each WLM of exposure above background produces a finite increase in lung cancer risk. Therefore, one must speak in terms of what is acceptable risk rather than what level of exposure is safe. The NIOSH risk assessment estimates that exposure to a cumulative 120 WLM of radon daughter exposure (above naturally occurring background) will produce slightly more than a doubling of risk of death from lung cancer compared to a population only exposed to background levels. A simplification of this risk assessment for exposures below 1000 WLM would indicate a linear upward trend in risk such that relative risk increases by 1.2% for each WLM of exposure to radon daughters. It should also be noted that this estimated risk coefficient for U.S. uranium miners is in the lower end of the range of risk coefficients reported in other international studies of miners. This range in lung cancer risk coefficients is 1.1% in a study of New Mexico uranium miners [34] to 3.6% per WLM in a study of Swedish iron miners [9].

The NIOSH Criteria Document [33] explains that using an actuarial approach, the quantitative risk estimates generated from these analyses indicate that miners who had the same characteristics as the

USPHS uranium miners cohort and who had accrued a cumulative occupational exposure of 120 WLM, would have a lung cancer excess lifetime risk of about 35-40 lung cancer deaths per 1000 exposed miners. The value of 120 WLM was chosen for this example because it corresponds to working 30 years and receiving an exposure equivalent to the current MSHA standard of 4 WLM. If the same miners had accrued a cumulative occupational exposure of 30 WLM, an excess lifetime risk of 5-10 excess lung cancer deaths per 1000 exposed miners would be expected. Table 1 of my testimony shows the number of occupationally-related excess lung cancers/1000 U.S. uranium miners.

This concludes my prepared testimony. I will be pleased to answer any questions.

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Table 1

NUMBER OF OCCUPATIONALLY-RELATED
EXCESS LUNG CANCER/1000 U.S. URANIUM MINERS

Occupationally Accrued WLM/yr	Excess Lung Cancer/1000 U.S. Uranium Miners*
4	35-40
3	25-30
2	15-20
1	5-10

* Assumes 30 year working lifetime in uranium mining.

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Senator BINGAMAN. Thank you very much. We will have some questions of you when we get through with the other testimony.

Our next witness is Stewart Udall, who is the former Secretary of the Interior, who has taken a real leadership role in advocating the rights of miners who were exposed to this radiation and who have gone uncompensated.

I am very pleased to say Stewart Udall is not only a great American; he is a great New Mexican now, having become a resident of Santa Fe, and we are very pleased to have him here today as a witness. Stewart.

STATEMENT OF STEWART UDALL, FORMER SECRETARY OF THE INTERIOR

Mr. UDALL. Thank you. Thank you, Mr. Chairman. With this turnout today, this is a very emotional day for me. I first came, and Ambassador Bill Mahoney, who is sitting here, from Phoenix, a Phoenix lawyer, we came here 11 years ago to Red Valley and held hearings.

And we tried to sue the mining companies, and we failed. We tried to sue the U.S. Government under the Federal Tort Claims Act, and we failed. We appealed through the Federal court system, all the way to the U.S. Supreme Court, and the doors were closed against us.

This fight because the Federal judges, as everyone has noted, said this is a tragedy, but it cries out for redress, go to Congress; Congress is the proper forum. And even a year ago, I will be frank to say, Mr. Chairman, I thought of this as an uphill fight, with the endorsement of this legislation by these two senators.

And I want to say to my Navajo friends, these are men, one a Republican, one a Democrat, who have a lot of influence in Washington. I know that they are supporting this legislation. I just wish Senator DeConcini and Senator McCain, one a Republican and one a Democrat, were getting it lined up.

I don't know whether there is a Navajo saying that's comparable, but we whites have a saying, "It is a long road, that doesn't have a turn," and some of us have been on that road for 11 years, searching for some kind of justice.

And this turnout today, I want to say to the Committee, these people are here because their families, their relatives have been impacted by this. And you have to realize, I was the congressman representing the district on the Arizona side of the line, where most of the mines were, beginning in 1955.

And when the uranium mining industry came to this part of the Navajo Reservation, most of the people had not had sufficient education to be familiar with the English language. They were living in a pastoral, primitive way, and suddenly, here to serve the national interest, to serve the national security, here came the American industrial system, and there was a tragic failure. I don't have time, but my statement covers some of it here.

And on this day, one thing I wanted to mention, in addition to what is in my statement, I believe it is just and fair to have some kind of Navajo amendment that would say that because of the special responsibilities the U.S. had towards these people, and because

of their failures, because we had here not only a failure to warn, a failure to reveal the dangers; we had what amounts to medical malpractice.

The government was responsible for the health of these people, and whether we simply tell those who administer this law as it is passed that they should be liberal in interpreting it, where Navajos are concerned, because of this special responsibility, I think something should be done.

I have used up my time. I simply want to say that I think there is a turn in the road. Senator Domenici and I—I testified before his committee 10 years ago. This has been a long search. I have never been able to explain. I was ashamed, in a sense, of our system of justice.

I said to the Navajos that we represented, "Believe in our system of justice; there will be justice." I can't explain to them sovereign immunity. I can't explain to them that the king can do no wrong. There is no way that I can explain it in any rational way.

But I am enormously encouraged because we have support from people like Senator Bingaman and Senator Domenici. I am encouraged because the Navajo Tribe, they watched our legal fight over the years, and they never lifted a finger to help us. The Navajo Tribe, six or eight months ago, passed a resolution. Chairman Haskie is here today, and they have provided an enormous amount of help.

So this is a day of hope for all of those in this room, Mr. Chairman, and I can't express my warmth and feelings for the two Senators who are here today, because I think their support is going to make the difference in Washington. Thank you.

[The prepared statement of Mr. Udall follows:]

Statement of Stewart L. Udall

to

MINERAL RESOURCES DEVELOPMENT AND PRODUCTION SUBCOMMITTEE

of the

SENATE ENERGY AND NATURAL RESOURCES COMMITTEE

March 13, 1990

at Shiprock, New Mexico

I am a lawyer and I am submitting this statement on behalf of clients I and about fifteen other lawyers have represented in the federal courts of the United States for over a decade. They include approximately 900 families who lived downwind from the Nevada Test Site, over 200 Navajo Indians who are widows of deceased Navajo miners or living miners who worked in uranium mines on the Colorado Plateau, and about 30 non-Indian widows of miners or living miners who worked in uranium mines in and about Marysvale, Utah.

Nearly all of these victims filed claims against the United States pursuant to provisions of the Federal Tort Claims Act (FTCA) and were plaintiffs in actions subsequently filed against the government in federal district courts. Thereafter (in some instances after lengthy trials), these victims were denied access to justice and cast out of the federal courts as a result of rulings based on judicial findings that when Congress enacted the FTCA in 1946, it intended that the United States should be shielded from liability under the doctrine of sovereign immunity.

These courts have effectively pronounced that "the King can do no wrong" -- that there are some things that are

more important than justice. This collective pronouncement has been made notwithstanding the fact that some of the federal judges either found in favor of some of these victims or wrote agonizing opinions in which they affirmed that the sacrifices made by these citizens "cry out for redress." Indeed, some of these judges were so appalled by the outcome that they included words in their written opinions counselling these victims to seek such redress from the Congress of the United States.

But these federal courts were not the only ones to direct these victms to Congress. In 1980 the House Subcommittee on Oversight and Investigations of the Committee on Interstate and Foreign Commerce conducted an exhaustive probe into the circumstances surrounding the testing in Nevada. The subcommittee not only unanimously found that the government was guilty of egregious negligence but concluded their report with this macabre observation: "<u>The greatest irony of our atmospheric nuclear testing program is that the only victims of U.S. nuclear arms since World War II have been our own people.</u>"

And so, these victims come to you at the end of a very long trail. These are the victims of the government's negligence in the first reckless (hasty) phase of the atomic age. These victims were, in different guises, unwitting soldiers of the cold war whose lives were sacrificed as a direct result of actions taken by federal officials who were in charge of programs that were integral elements of vital

national security activities of our government. These victims are the human debris of the cold war. Now, as we approach the end of the cold war, I urge you to admit the federal government's past mistakes and salute these tragic soldiers with a compassionate gesture.

Objections have been raised by the Department of Justice (DOJ) with respect to the proposed Radiation Exposure Compensation Act. The objections, stated in testimony before the Subcommittee on Administrative Law and Governmental Relations of the House Judiciary Committee last November, are primarily two-fold.

First, DOJ argues that there is no scientific evidence to show that the injuries sustained by the victims are the result of radiation exposures generated by activities of the federal government. There is, however, an overwhelming abundance of scientific evidence. Moreover, the federal judges who sat in judgment in the lawsuits brought by these victims -- and members of the House of Representatives who investigated the tragedies of the downwinders -- found in many instances that the victims' injuries were caused by federal activites and that the evidence of medical causation was overwhelming.

Indeed, in the case of the uranium miners, the Public Health Service used the miners as guinea pigs to study the effects of radiation. The principal investigator of that study, Dr. Victor Archer, presented his findings to this Committee that the uranium miners were exposed to

extraordinary levels of radiation that caused lung cancer and other nonmalignant respiratory diseases.

The DOJ has also argued that the proposed Radiation Exposure Compensation Act would unnecessarily provide payments to persons who can pursue worker compensation remedies. Such an objection completely ignores the reality of these victims. Most of the Navajo uranium miners were uneducated, did not speak English and lived in very remote areas within the Navajo Nation. With very few exceptions, these victims did not pursue this remedy because they knew nothing about their legal rights. By the time many became aware of the existence of worker's compensation, the statute of limitations had run. For others the remedy has been unavailable because their last place of employment is no longer in existence or its insurance records cannot be located. For those who have been fortunate enough to avail themselves of the remedy, awards have proven grossly inadequate, in some cases less than $100 per month.

The case of the Navajo uranium miners is one of egregious government malfeasance. The federal government has a special trust relationship with respect to Indian tribes. It owes a special duty of care to protect them and to provide for their health care. The Atomic Energy Commission (AEC) and the Public Health Service (PHS) violated this special duty of care by not warning the Navajos and ensuring their protection.

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At the time uranium mining commenced on the Navajo Reservation in 1949, AEC and the PHS officials not only knew all about the perils of uranium mining but some of their employees were numbered among the leading experts in the world on this subject. They also knew from the outset that if the Navajo mines were ventilated, using the kind of low-cost existing techniques used in all of the copper mines in the southwest, an epidemic of lung diseases could be avoided. Yet, in a reckless rush to expedite the domestic output of uranium for its nuclear weapons program, the AEC stood by and allowed scores of Navajo miners to work in mines that contained lethal levels of radiation.

After the mining was underway and AEC officials received reports detailing the massive doses of radiation the unranium miners were inhaling in their workplaces, the AEC hid behind a hoax that it was premature to draw conclusions about radiation hazards in U.S. mines until there were sufficient deaths to demonstrate that there was a lung cancer epidemic on the Colorado Plateau. (Medical experts cynically refer to such an unconsciable deathwatch approach to any industrial epidemic as a wait-for-bodies-in-the-morgue study.) Thereafter, it took the stance that it was "concerned" and, like a good neighbor, was doing its best to help the states and the mining companies come to grips with <u>their</u> mine safety problems. This was an outlandish abdication, for federal

officials also knew that the mining companies knew practically nothing about this problem -- and also knew that state officials had no legal authority to enter Indian Reservations and close mines or regulate safety coonditions on such Reservations.

From the inception of this tragedy, the federal government had the funds, the medical knowledge and the satety know-how to protect the Navajo miners. Indeed, the AEC had at hand two alternative, time-tested remedies that would have resolved the problem forthwith. It could have written safety standards into its ore-procurement contracts (as one of its top safety officials had recommended); or it could have made a phone call to the U.S. Department of Labor and requested that that agency take over and promulgate the kind of safety standards and regulations it regularly imposed on federal contractors under authority contained in the Walsh-Healey Public Contracts Act.

When none of these steps was taken, the tragedy of the Navajo uranium miners began moving on a inexorable avenue of death.

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Of all the civilian tragedies spawned by the AEC's neglect of the radiation safety duties imposed upon it by Congress, the most poignant involved 200 Navajo Indians who worked in some of the first uranium mines in the United States. These Indians were living pastoral lives in the remote, redrock country west of Shiprock, New Mexico when the AEC began its campaign to develop domestic supplies of uranium. A cruel irony permeates their story, for the Navajo's home environment was so clean and their lifestyle so simple, that physicians who practiced medicine on their reservation in the 1950's observed a curious absence of certain kinds of cancers.

But the Navajo miners were doomed the moment the search for U.S. uranium began. They were doomed because their Reservation contained rich deposits of uranium located near the surface of the earth. They were doomed because the U.S. government needed uranium and the Atomic Energy Commission was inclined to sacrifice lives to expedite its output. They were doomed because the long years it would take for the radiation that lodged in their lungs and bones to evolve into an epidemic of lung cancer would allow the AEC apparat to pretend their health was not imperiled. And athey were doomed because their inability to communicate in English put them at the mercy their employers

and the federal health officials who appeared from time to time to ask them questions and give them physical examinations.

These Navajo miners and their families were doomed to bear all the burdens of the lung diseases that devastated their lives because they did not comprehend what had happenead -- and nobody informed the widows that they were entitled to death payments under the worker's compensation laws of the states in which they worked. And they were doomed because, contrary to the myth of states-responsiblity the AEC brandished as its shield for nearly two decades, state safety officers had no authority to enter the Navajo Reservation or to compel the companies mining Indian ores to ventilate their mines.

All of the uranium miners on the Colorado Plateau were victims of the AEC's abdication. If the life-saving safety program the AEC's Merrill Eisenbud envisioned in 1948 had been carried out, the workers would have known what steps to take to protect themselves: miners and mine foremen educated about radon risks would have understood the dangers of dead air and would have arranged the air vents so that fresh air was blowing in the stopes where radon-emitting ores were being blasted from the earth and in the tunnels where they performed their daily duties.

For all of the reasons cited above, I urge members of Congress to support this modest, compassionate legislation. And I also unswervingly support the "Indian amendment" that has been proposed by the Navajo Tribe. In my view, the overriding obligations to Indians the federal government bears putsuant to its trust responsibility -- and the further, compelling circumstance that federal physicians who provided the only health care available for all of the Navajo miners utterly failed to discharge medical and ethical duties they owed to these miners -- makes such an amendement imperative.

In reality, these native Americans were soldiers of the cold war whose lives were sacrificed to fulfill ill-considered national security goals of their nation. On behalf of these innocent victims of federal negligence, I thank you for hearing their plea that Congress, on behalf of the nation, recognize the extreme sacrifices they made for their country.

Stewart L. Udall
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Senator BINGAMAN. Thank you very much. We will have questions, I am sure, as we get through the rest of the testimony.

Our next witness is Lynda Taylor, who is the Director of the Radiation, Toxics and Health Project for Southwest Research and Information Center in Albuquerque. She has worked on this issue and related issues for more than a decade and is well known by everybody who has had an interest in these issues for her advocacy and her knowledge in the area. Lynda, thank you for being here.

STATEMENT OF LYNDA TAYLOR, DIRECTOR, RADIATION, TOXICS AND HEALTH PROJECT, SOUTHWEST RESEARCH AND INFORMATION CENTER

Ms. TAYLOR. Thank you, Senator. First of all, I would like to thank you, as Chair of the Subcommittee today, for bringing your Committee and your staff here to Shiprock, so that the people who have been affected by these uranium activities can participate in this process and hear what is being said here today and also present their testimony personally before you.

I would also like to thank Senator Domenici for his appearance here today and his long-time commitment to this issue. Furthermore, in their absence, I would also like to acknowledge Senator Hatch and Congressman Owens for their most recent effort to obtain compensation for both downwind radiation fallout victims, as well as the uranium miners.

My organization has been involved with uranium activities for the past 11 years, and my involvement with the Navajo families who have been affected by uranium activities goes back 11 years, as well. I learned about this situation in 1979 and have witnessed how difficult and particularly hard this problem has been for the traditional Navajo families in this area where early uranium activities have taken place. We will hear more about this testimony from the people today themselves.

Due to its Federal trust relationship with the Native Americans, which was violated during the early uranium activities, I believe that the U.S. also has a greater responsibility to help these miners and their families from the pain and suffering that they have incurred over these years.

Hundreds of these miners are very sick or have already died from lung diseases related to their work in the mines due to radiation and uranium dust exposure. Compensation for their suffering is long overdue, and it is a fair and equitable thing to do for these people whose health and lives were traded for the security of this nation.

The compensation bill now pending in Congress would provide some measure of government acknowledgment and financial compensations to the victims. My organization strongly supports this bill, and in my testimony, which I have already submitted for the record, I list three major reasons which support the need for this bill, much of which has already been expressed by earlier testimony.

One major reason is that the death and injury from lung cancers and serious respiratory diseases has reached epidemic proportions among these early uranium miners, and it is due to excessive radi-

ation and uranium particles and dust as a result of those dirty mines and the lack of regulations.

Secondly, the Federal Government was the sole purchaser for most of the early uranium mining years, and it was aware of the dangers of radiation but failed to warn the uranium miners or to institute any mandatory radiation protection standard in the uranium mines until 1971, more than 20 years after the mining was started in this area.

And third, that the former uranium miners and their remaining families had little or no compensation for their suffering, because of both workmen's compensation and court remedies not being available to the vast majority of them, creating both great personal pain and financial hardship.

Relating to point number one, I outline in my testimony, and include numerous exhibits, published medical studies which clearly demonstrate that lung cancer in this early population is increased by radon exposure, regardless of age and smoking history. I further outline in my study information that shows nonmalignant lung diseases, such as fibrosis and silicosis, are substantially increased in this population, probably as a result of exposure to any one or a combination of radon, uranium particles and dust.

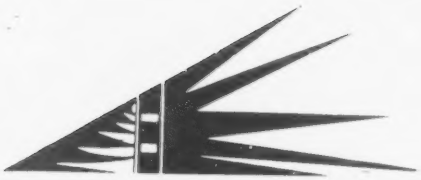
Therefore, we would like to ensure that all nonmalignant lung diseases related to uranium mining during this early period, particularly silicosis, be included in the bill for compensation. And there is a question right now as to whether silicosis will be compensated.

On point number two, the government's dual role of both purchasing the uranium and not mandating radiation protection programs for 20 years, even though it was aware of the hazards, clearly puts a burden on the government for compassionate payments to those who have suffered for so long.

And on point number three, I discuss the problems these victims have had trying to get remedies through workmen's compensation or the courts. Stewart Udall and Earl Mettler, who will testify later, have addressed these issues in very great detail in their personal statements.

In closing, the time is long overdue to help these people. Congress is the only source of hope that is available to them, and the compensation bill that is now pending in Congress is the appropriate vehicle to set up the compensations program for these folks. Thank you very much.

[The prepared statement of Ms. Taylor follows:]



SOUTHWEST RESEARCH AND INFORMATION CENTER

STATEMENT ON THE IMPACTS OF PAST URANIUM MINING PRACTICES

TO THE

MINERAL RESOURCES DEVELOPMENT AND PRODUCTION SUBCOMMITTEE

OF THE SENATE ENERGY AND NATURAL RESOURCES COMMITTEE

by Lynda Taylor, Director

Radiation, Toxics and Health Project

Southwest Research and Information Center

March 13, 1990

Thank you Senator Bingaman for holding and chairing this subcommittee hearing in Shiprock today. It will enable representatives of people directly affected by past uranium mining practices to present their story before you. I would also like to express appreciation to Senator Domenici for his appearance and continued support through the years of the affected uranium miners and their families. It has been over ten years since he sponsored his own uranium miners' compensation bill. And I want to applaud the dedication and commitment of Senator Hatch and Congressman Owens in seeking compassionate payments for the uranium miners, as well as downwind radioactive fallout victims, through the Radiation Exposure Compensation Act (the "Act") now pending in Congress.

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Mr. Chairman, I am grateful for the opportunity to provide a statement for the record today. My name is Lynda Taylor. I am Director of the Radiation, Toxics and Health Project for Southwest Research and Information Center, a non-profit organization that has worked on uranium-related issues for over a decade. I believe that the Act mentioned above, if passed, will provide some measure of financial relief for the miners and their families who were hurt by past government-initiated uranium operations. These early miners were not told by the government about the radiation hazards in the uranium mines.

The federal government, in fact, instituted a crash program of exploration and mining by private industry in order to develop a dependable domestic supply of uranium ore for its new atomic weapons program. The program, begun in April of 1948 through the Atomic Energy Commission, emphasized production of uranium over safety measures. Though there was information available to the government on the hazards of radiation in the uranium mines, mandatory action to reduce exposure was not taken until 1971. The government never warned those early uranium miners that radiation was dangerous and that their health -- or lives -- were at risk.

I have worked with many of the Navajo families who have been affected by past government uranium mining activities. Like many others testifying before you here today, I have been involved because of a deep personal commitment which began eleven years ago when I first learned of their plight back in 1979. For

the traditional Navajo families from the Four Corners Area, the tragic legacy of death and disease concentrated in rural Navajo tribal communities where early uranium operations took place continues to bring great pain and suffering to these people. You will hear more about this from them today. Due to its federal trust relationship with native americans, the United States government has even more reason to provide a federal mechanisms for compensating these miners and their families.

There are now significant numbers of former uranium miners, both indian and non-indian, who mined uranium for the nation's nuclear weapons program in the past, that have died or are suffering from lung cancer and respiratory diseases. They were never told about the dangers of radon, a radioactive gas that enveloped them as they dug out the uranium ore in poorly ventilated mines year after year. They are still paying the price today for the inadequate safety and health standards that were then in force.

Furthermore, many of these early miners have "fallen through the cracks" of existing state workmen's compensatoin systems, and they and their families are not being adequately compensated for their mine-related illnesses due to strict statutes of limitation and unrealistic burden of proof requirements which do not take into account the long latency period of uranium mining diseases.

However, early attempts at Congressional legislation as well as lawsuits filed aginst the government and the uranium companies have been unsuccessful. Such efforts date back to at least 1979

when Senator Pete Domenici was first alerted to the fact that significant numbers of miners were ill or dead already died of lung cancer and respiratory ailments. A series of unsuccsssful compensation attempts were made through Congress during the late seventies and early eighties. Congress may have placed its hopes on lawsuits pending during that time on behalf of uranium miners against the government.

However, a 1985 ruling on the uranium miners' lawsuit by the Ninth Circuit Court of Appeals, and later upheld, has clearly put the onus on Congress to decide what remedy should be forthcoming for those victims. Judge Blaine Anderson, in speaking for the three-judge panel said, "This is the type of case that cries out for redress, but the courts are not able to give it; Congess is the appropriate source."

Compensation under the proposed Act is the fair and equitable thing to do for these people whose health and lives were traded for the security of this nation. It is the fair thing to do for the miners and their dependents who would be assisted, and fair to the taxpayers of this country who were and are the beneficiaries of the work which these miners performed, principally in the interest of national defense.

The excessive levels of radioactive radon gas and uranium dust in the early uranium mines which gave rise to the lung diseases no longer prevail. But during the long latency period between exposure and diagnosis of these disease -- in some cases over forty -- hundreds of former uranium miners have died and

others are sick and dying. The widows left behind suffer long after the loss of their husbands; many children have grown up in this area without a father or grandfather.

Compassionate payments of the nature described in the Act for these victims is long overdue. As it relates to the miners, this Act essentially would provide "compassionate payments" from a new government trust fund to those who worked in Colorado, New Mexico, Arizona, or Utah between January 1, 1947 and December, 1971; who were exposed to 200 or more working level months of radiation; and developed lung cancer or other serious respiratory diseases. If deceased, the miner's family would receive the benefit.

Southwest Research and Information Center strongly supports the proposed Radiation Exposure Compensation Act. However, we would like to note for the record our hope that certain non-malignant respiratory diseases caused by uranium particles and dust be clearly specified as deserving of compensation for all former uranium miners otherwise eligible for payments. This issue is discussed in more detail below.

What follows is a more detailed discussion that supports the above-described program for uranium miners' compensation. It includes three major points:

1. That death and injury from lung cancers and serious respiratory diseases are prevalent among early uranium miners from radiation, uranium particles and dust;

2. That the federal government was the sole purchaser of uranium for most of the early uranium mining years, that it was aware of the dangers but failed to warn uranium miners or to institute mandatory radiation protection standards in uranium mines until 1971 and therefore has a moral responsibility to provide compassionate compensation to the victims.

3. That the former uranium miners or their remaining families have had little or no compensation for their suffering because both workmen compensation and court remedies are not available to the majority of these victims, that Congress, as the court has stated, is the last hope for these victims, and that the proposed Act would set up an appropriate federal vehicle for compensation.

1. Death and injury from lung cancers and serious respiratory diseases are prevalent among early uranium miners from radiation, uranium particles and dust.

A. Lung Cancers. Contrary to the Department of Justice Statement before a subcommittee of House Judiciary November of last year, the link between a significant excess of respiratory cancer among early uranium miners due to excessive radiation exposure has been clearly established. I enclose for subcommittee review a complete copy of a statement entitled "Uranium -- the United States Experience: A Lesson in History" prepared in 1980 by Dr. Joseph Wagoner, formerly Special Assistant for Occupational Carcinogenesis at the Occupational

Safety and Health Administration and a former radiation epidemiologist for the U.S. Public Health Service. (Ex. 1)

This document provides a complete history of uranium-related diseases among miners through January of 1980, and demonstrates that excessive radiation, primarily from radon gas and radon daughters, was responsible for the excess lung cancers in a Public Health Service study of 3,500 white and 780 Indian males who had worked underground in uranium mines in the Colorado Plateau beginning with July, 1950.

More recently-published articles verify the causal relationship between radiation exposure of early uranium miners and excess lung cancers, irrespective of age and smoking history. A paper presented at the Radiation Hazards in Mining conference in Golden, Colorado in October of 1981 by Waxweiler, et al entitled "Mortality follow-up through 1977 of the white underground uranium miners cohort examined by the U.S. Public Health Service," indicated 185 white uranium miners had died of lung cancer, a five-fold excess risk of death among this group -- and more are expected to die. (Ex. 2, p. 826).

Two additional studies on Navajo uranium miners by Gottlieb, etal and Samet, et al (Ex. 3 and 4) demonstrate a clear relationship between uranium mining radiation exposure and lung cancer. And lastly, Roscoe, etal published a paper in the Journal of the American Medical Association in August of 1989, entitled "Lung Cancer Mortality Among Nonsmoking Uranium Miners Exposed to Radon Daughters, demonstrated once again that lung

cancer is increased with exposure to radon in early uranium mines even among miners who never smoked cigarettes, pipes, or cigars. (Ex. 5)

Therefore, the provisions in the Act which would compensate former uranium miners exposed to radon gas who have developed lung cancer, regardless of smoking history, is scientifically and medically well-founded.

B. Non-malignant Respiratory Diseases.

Although the Act clearly calls for compensating former uranium miners with some non-malignant respiratory diseases, the Act appears to include only those non-malignant diseases which have been linked to radiation exposure, such as fibrosis. Other diseases found in excess among this population such as silicosis may be left out because a clear relationship between radiation cause and effect has not been established. The point here is that silicosis, as well as other non-malignant respiratory diseases, have been clearly linked to working in these early uranium mines, most probably associated with dust from blasting. The same poor conditions in the early mines that gave rise to the lung cancers also resulted in non-cancerous respiratory diseases like silicosis. Therefore, they too should be part of any uranium compensation program.

The same Public Health Service study of the 4,000-plus uranium miners mentioned above, showed a two-fold excess of bronchitis and a five-fold excess of "other non-malignant respiratory disease" in this group. The latter consisted mainly

of silicosis, emphysema, and fibrosis. (emphasis added) (See Ex. 2, p. 826). As early as 1964, Archer, et al concluded that chronic exposure to airborne radiation, as encountered in uranium mines, promoted pulmonary emphysema, fibrosis and chronic bronchitis. (Ex. 1, p. 6)

In support of this were observations by Wagoner, et al, who demonstrated that the mean cumulative dose of radon daughters for uranium miners with nonmalignant respiratory diseases exceeded that of miners with nonrespiratory diseases. Again, in 1976, Archer, et al demonstrated that deaths due to nonmalignant respiratory disease among United States miners had reached epidemic proportions with 80 such deaths observed as contrasted with only 24.9 expected. (Ex. 6). Archer et al further demonstrated an exposure-response relationship between radon daughter exposure and respiratory diseases after excluding cancer and tuberculosis. This exposure-response relationship persisted within nonsmoking and smoking categories. (Ex. 1, pp. 6,7).

Based on the above, it is known that the poorly-ventilated uranium mines resulted in dust-induced diseases such as silicosis and pneumoconiosis from both the uranium ore itself and other underground rock components. Senator Domenici's 1979 bill acknowledged this problem by including compensation for respiratory diseases that were either "radiation or dust-induced," such as silicosis, which resulted from early uranium mining employment. (Ex. 7)

2. The federal government was the sole purchaser of uranium for most of the early uranium mining years, it was aware of the dangers but failed to warn the uranium miners or to implement mandatory radiation protection standards in uranium mines until 1971.

SRIC supports the eligibility time period in the Act which begins January 1, 1947 and ends December 31, 1971, the timeframe during which the federal government was the primary purchaser of the uranium for its atomic weapons program.

The Federal Government was the sole purchaser of uranium for defense purposes during the period 1948 through 1962, when the commercial nuclear industry, with much support from the government, began to purchase uranium as well. The government continued to purchase uranium up through the end of 1970, when government uranium ore contracts expired. Testimony on this point by James T. Ramey, former Commissioner of the U.S. Atomic Energy Commission before the House Select Subcommittee on Labor of the Committee on Education and Labor in April and May of 1968, bears this out. (Ex. 8, pp. 79, 80). However, the government failed to use already available scientific evidence and medical data to upgrade health and safety standards in the during this time period.

As early as 1957 the U.S. Public Health Service has acknowledged the risks of radiation in the uranium mines and formally proposed the current standard for control of radon daughter exposure. It was not until the health hazards involved

31-121 O - 90 - 3

in the mining of uranium were discussed at a conference of the governors of the uranium-producing states held in Denver on December 16, 1960 that several states began to institute radiation control programs, according to Duncan Holaday's May 17, 1968 letter to Representative James Harrison, House Select Labor Subcommittee. (Ex. 8, pp. 101,102.)

However, U.S. Bureau of Mines ventilation surveys showed that in 1962, sixty-eight percent of uranium mines in the Colorado Plateau Area were still found in excess of the recommended level. By 1966, only forty-four percent of these uranium mines had reduced radiation levels to the recommended limit, and as late as 1968, only sixty-nine percent of underground uranium mines had controlled radon daughters to the recommended level. (See Ex. 1, p. 5).

It was not until the year 1971 that the Federal Metal and Non-Metallic Mine Safety Act of 1966 -- the first Congressional Act mandating standards for uranium mines -- was fully implemented.

Therefore, SRIC believes there are several important reasons why the 1971 date was chosen, and should remain, as a cutoff for eligibility for these miners.

3. The former uranium miners or their remaining families have had little or no compensation for their suffering because both workmens' compensation and court remedies are not available to the majority of them, and Congress is their last hope.

As described in a statement by Senator Pete Domenici on the Congressional Record September 27, 1979, "existing workmen's compensation laws in most States do not provide adequate benefits to afflicted uranium miners or to their survivors due to strict statutes of limitations and unrealistic burden of proof requirements which do not take into account the long latency perod of radiation-induced diseases." . . . and "under existing workmen's compensation laws in most States, uranium miners and their survivors are often not provided compensation benefits for disability or death resulting from dust-induced latent diseases arising out of employment in the mines."

And the statement of Earl Mettler, Esq. submitted to before a House subcommittee on Judiciary last November, gives at least two additional reasons why laws applicable to these early miners do not provide an adequate remedy. They are the requirement that actions be filed against the last employer, even though many last employers are no longer in business and, if there is recovery, the amount is extremely low because it is based on a percentage of the earnings in the mining employment performed many years ago, dating back to the late forties.

Finally, as noted above, the courts have now spoken with regard to compensation of these early uranium miners and have ruled that it is Congress, not the courts, that will need to develop an appropriate and just remedy for these victims.

The proposed Act is a long overdue appropriate and just remedy for these victims, and we urge your continued support on their behalf. Thank you.

U R A N I U M

THE UNITED STATES EXPERIENCE

A LESSON IN HISTORY

"There is no more critical imperative today than this society's assertion of the absolute priority of individual over institutional interests and of human over economic values."

Mr. Willard Wirtz
Former U. S.
Secretary of Labor

Joseph K. Wagoner, S.D.Hyg.
Research Epidemiologist
Environmental Defens Fund
1525 18th Street, NW
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JANUARY 1980

EXHIBIT I

HISTORICAL PERSPECTIVES

Respiratory disease among underground miners has long been noted. Indeed ancient writings made note that slave labor was often used in mines, an assignment synonymous with a death sentence due to the excessive concentration of lung-impairing dust in the mine air.[1]

As early as the year 1546, miners of uranium-bearing ores in the Erz Mountains of Central Europe were reported to have an unusually high frequency of fatal lung disease.[2] The real nature of this pulmonary disorder among miners of the Schneeberg, Germany, area was not identified, however, until 1879 when Harting and Hesse first clinically and anatomically diagnosed it to be malignant neoplasia.[3] In 1913, Arnstein reported that of 665 Schneeberg miners dying during 1875-1912, forty percent or 276 died of lung cancer.[4] Pirchan and Sikl in 1932 reported that of 17 deaths observed during 1929-1930 among miners of uranium-bearing ores in Joachimsthal, Czechoslovakia, fifty-three percent or 9 were due to cancer of the lung.[5] These same investigators, noting the long latent period between onset of mining and death due to lung cancer, the pathologic absence of silicosis and the histologic preponderance of small cell undifferentiated carcinoma, concluded that the most probable cause of these tumors was the radiation in the air of the mines. These investigators also made note "the miners themselves state that discovery of a rich uranium vein is always followed some years later by a strongly increased mortality among them."[5] In 1939, Peller reported that the lung cancer mortality rate among miners of uranium-bearing ore in Joachimsthal (9.77 per 1000) was several times higher than that of males in Vienna, Austria (0.34 per 1000).[6] Experimental support for the role of airborne components of uranium-

bearing ore dust in the etiology of this unusual respiratory cancer pattern among humans was provided in 1942 by Campbell[7] who reported the induction of lung tumors in 20.3 percent of mice exposed by inhalation to dust from the Joachimsthal mines, whereas only 2.1 percent were found in unexposed controls.

UNITED STATES EXPERIENCE

ORIGIN OF THE PROBLEM

By the 1940's, when large-scale mining and milling of uranium ores for nuclear weapons production started in the United States, this lung cancer experience and its probable relationship to radioactivity within uranium mines was widely published and generally accepted as factual by the international scientific community,[3-10] but little heeded by government or industry.[11-16]

The United States government wanted a uranium mining and milling industry. In pursuit of that goal private business accepted the task of locating, mining and processing uranium-bearing ores. The Atomic Energy Commission (AEC) contributed with geological surveys, free testing and assaying service and, more noteworthy, a guaranteed market. During the late 1940's and early 1950's uranium was searched for more than all other metallic minerals combined. The "big search" for uranium has been described as the greatest mining boom since the California gold rush 100 years before.[17] In the United States, all uranium ores were produced from privately owned mines and ninety percent of the uranium ores processed in privately owned mills. Yet, the Atomic Energy Commission retained full control over the source and disposition of uranium under licenser and procurement authority of the Atomic Energy Act of 1946.[17] In like manner, the Atomic Energy Act of 1946 gave the Atomic Energy Commission health and safety responsibility for uranium ore and products of subsequent processing

contended that they were not required to regulate radioactivity within the mines,* there was at the same time no adjudicated prohibition against such regulation under the licenser or procurement mechanism.[18] Indeed at the Joint Committee on Atomic Energy hearings on Employee Radiation Hazards and Workmen's Compensation in 1958, it was pointed out that AEC contractors fall under the Walsh Healy Public Contracts Act and thus AEC had direct control over mining procedures and methods of operation.[19] Furthermore, during the same period of time, the AEC did evoke a regulatory posture with regard to beryllium, a highly toxic material also considered strategic for weapons production.[16] As a result of this AEC decision, all regulatory responsibility for radioactivity within uranium mines was delegated by default to the various state departments of health, most of whom had little or no staff capability to mount field inspection and monitoring programs for radon and radon daughter exposures within uranium mines.

With the advent and intensification of uranium mining and processing in the United States, it was natural, therefore, that members of the medical research community should express their public concern for health hazards indigenous to the uranium production industry.[12-14] As a result of these expressed concerns, the United States Public Health Service in 1950 undertook a program to delineate and mitigate the hazards of internal radiation emitters common to uranium mines and mills. This program consisted of three phases: an industrial hygiene survey of environmental conditions and engineering control practices within uranium mines and mills, a cross-sectional survey of medical

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* The phrase "the place of deposit in nature" in mining law is reported to mean the ore vein itself and not the mine.

signs and symptoms manifest by uranium miners and millers and a cohort study of cause-specific mortality patterns experienced by miners and millers.

URANIUM MINING

Environmental Conditions

Environmental sampling conducted in 1949-50 showed that the atmospheric concentrations of radon in United States underground uranium mines were grossly in excess of the permissible concentrations recommended in 1940[20] and similar in magnitude to those concentrations reported earlier in the European mining operations in Joachimsthal and Schneeberg.[21] None of the U.S. uranium mines at that time had mechanical ventilation for dust control. In 1952, following a recognition that the principal radiation hazard in the uranium mine atmosphere was not radon itself, but the radioactive decay products of radon -- isotopes of polonium, lead and bismuth (Figure 1), the U.S. Public Health Service (Table 1) showed that about forty-five percent of uranium mines were experiencing radon daughter concentrations ten times in excess of one working level (1.3×10^5 MeV of alpha energy from radon daughters per liter of air or 300 pc per liter of air).[22] In like manner, environmental sampling in 1953 showed that significant radon and radon daughter concentrations were present in the atmosphere of nonuranium mines in Colorado, i.e., up to 2100 pc per liter of air for radon and 640 pc per liter of air for radon daughters.[23]

In February 1955, the Governor of Utah convened a conference in Salt Lake City, Utah, for purposes of considering a standard for uranium mines. The report of the Conference stated that the radiation hazards in uranium mines were real and that efforts should be made to reduce the atmospheric concentrations of radon daughters to 300 pc per liter of air or one working level (WL).[24] Between 1952

and 1957 (Table 2), some improvement in the control of radon daughter exposure had been implemented. Nevertheless, during 1952 approximately twenty-five percent of U.S. uranium miners were mining under conditions of radon daughter exposure in excess of 1000 pc per liter of air. In light of these conditions, the United States Public Health Service* in 1957 formally proposed one working level as the standard for control of radon daughter exposure in uranium mines.[22] Three years later, in 1960, the American Standards Association officially adopted one working level as the standard.[25]

Ventilation surveys conducted by the U.S. Bureau of Mines in 1961-62, however, showed that some underground uranium mines were still relying upon natural draft pressure for ventilation.[26] Where some form of mechanical ventilation was installed, it was found on occasion either to be so slight that it did not exceed natural draft-induced airflow or nonfunctional due to inoperative blowers.[26] As a result, in 1962, sixty-eight percent of uranium mines in the Colorado Plateau Area were still found to exceed one working level and four percent were in excess of ten times the recommended standard of radon daughter exposure (Table 3).[21] By 1966, only forty-four percent of U.S. underground uranium mines had reduced radon daughter concentrations to less than one working level.[27] During that same year fourteen percent of uranium mines were operating at radon daughter concentrations three or more times the adopted standard. As late as 1968, only sixty-nine percent of underground uranium mines had controlled radon daughter exposures to less than one working level.[28]

Non Neoplastic Respiratory Diseases

During the period 1950 through 1960, periodic medical surveys

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* The role of the U.S. Public Health Service was limited to research, support documentation for standards and public health education.

were conducted among miners and millers of uranium-bearing ores. Before 1950, both miners and mill workers were examined, but no systematic effort was made to examine all individuals actively working. During the 1954 through 1960 period, however, attempts were made to examine as many miners as possible. By way of this program, a total of 5,370 miners and millers submitted to pulmonary function, sputum cytologic and chest radiographic tests as well as physical examination. These miners and millers also gave detailed demographic, social and past occupational history data. Archer, et al.,[29] in 1964 demonstrated an association between underground uranium mining and an increased prevalence of "ambiguous and suspicious" cells in sputum, of shortness of breath, of persistent cough, of pneumoconiosis and possibly of wheezing and chest pain. This association persisted after consideration was given to the role of prior hard-rock mining other than uranium and cigarette smoking. In the same year, following additional analyses, Archer, et al.,[30] concluded that chronic exposure to airborne radiation, as encountered in uranium mines, promoted pulmonary emphysema, fibrosis and chronic bronchitis, all of which may contribute to pulmonary disability. In support of this were observations by Wagoner, et al.,[31-33] who demonstrated that the mean cumulative dose of radon daughters for uranium miners with nonmalignant respiratory diseases exceeded that of miners with nonrespiratory diseases. Karajovic, et al.,[34] in 1964 demonstrated medical findings among radon daughter-exposed miners in Yugoslavia similar to that reported among uranium miners in the United States, i.e., disorders of the upper respiratory passage, bronchitis with emphysema and pneumoconiosis. In 1976, Archer, et al.,[35] demonstrated that deaths due to nonmalignant respiratory disease among United States miners had reached epidemic proportions with 80 such deaths

observed as contrasted with only 24.9 expected (Table 4). Archer, et al.,[35] further demonstrated an exposure-response relation between radon daugher exposure and respiratory diseases after excluding cancer and tuberculosis. This exposure-response relation persisted within each smoking category, i.e., within those who were nonsmokers, and those smoking less than and more than one pack of cigarettes per day.

Neoplastic Respiratory Disease

As early as 1962, Archer, et al.,[36] and Cooper[37] reported a statistically significant excess of lung cancer mortality among a subset of uranium miners having three or more years of underground experience and having been followed during the period 1950 through 1959. A critique of this study concluded, "If after the European experience, there were any doubt as to the implication of radioactivity in the etiology of lung cancer they surely have been resolved by the findings of the present study to date."[38] This critique further stated, "The data to date, therefore, give no comfort to those who are concerned that the problem in American mines may become a disaster that in relative terms could be as great as the European experience and because of the larger population at risk, could be numerically very much greater."[38] Wagoner, et al.,[39] in 1963 demonstrated a significant excess of respiratory tract cancer mortality (47 deaths observed vs. 16.1 expected, $p<0.01$) among underground nonuranium miners who had received chronic exposure to radon and its daughters in the range of one to two working levels. In 1964, the Surgeon General's Advisory Committee on Smoking and Health concluded, however, "although the induction of lung cancer by radionuclides is probably in man, the evidence is not as firm as in animals."[40] In that same year, Wagoner, et al.,[33] reported a

tenfold excess of respiratory cancer among white uranium miners having mined underground for five or more years. This excess was not attributed to age, smoking, nativity, heredity, urbanization, self-selection, diagnostic accuracy, prior hard-rock mining or non-radioactive ore constituents, including silica dust. Wagoner, et al.,[33] also demonstrated that the mean cumulative radiation dose of uranium miners with respiratory cancer was significantly greater than that of miners with nonrespiratory diseases and than that of a sample of living miners matched on the basis of year of birth, year of initial examination and race. Whereas an excess of respiratory cancer mortality also was demonstrated among uranium miners with open-pit, surface or occasional underground experience, the excess was based upon small numbers (3 observed vs. 1.4 expected) and therefore not statistically significant.

Shortly thereafter, Wagoner, et al.,[41] reported an extension of the unusual lung cancer mortality among white underground uranium miners (22 observed v. 5.7 expected from 1950 through 1963). In addition, an exposure-response relation between airborne radiation (cumulative working level months) and the incidence of respiratory cancer was demonstrated as was the exclusion of cigarette smoking and time since onset of exposure as confounding factors in that relationship. Six circumstances supportive of a causal relation between airborne radiation and respiratory cancer among uranium miners were presented by the authors.

In 1967, Lundin, et al.,[42] demonstrated that during the period 1950 through June 1965, white underground uranium miners experienced 37 deaths due to lung cancer whereas only 7.3 would have been expected to occur on the basis of rates for the white male population of the Colorado Plateau Area. Archer and Lundin[43] in that same year con-

cluded that an exposure of 120 working level months (WLM) appeared to double the normal lung cancer incidence of uranium miners. Lundin, et al.,[44] subsequently demonstrated that through September 1967, 62 deaths due to lung cancer had occurred among white underground uranium miners as contrasted with only 10.02 expected to have occurred.

On the basis of these and other data, the Department of Labor in 1967 issued an order under the Walsh Healey Public Contracts Act to limit the maximum permissible exposure of uranium miners to 3.6 WLM during any 12 month period, i.e., a 0.3 WL standard.[45] Shortly thereafter the Joint Committee on Atomic Energy of the U.S. Congress began its lengthy review of radiation hazards in uranium mines[46, 47] to determine if, in their opinion, a new and safer standard was scientifically valid or economically desirous. In anticipation of this review, Lundin, et al.,[28] during the next three years undertook an in-depth analysis of the respiratory cancer experience among uranium miners. This analysis demonstrated a statistically significant excess of respiratory cancer at each cumulative radiation exposure category down to and including 120-359 WLM. In addition, Lundin, et al.[28] reported that through September 1968 white underground uranium miners had experienced 70 deaths due to lung cancer whereas only 11.71 would have been expected to occur, an excess experienced among uranium miners with and without other hard-rock mining backgrounds.

Using bone from uranium miners, Black, et al.,[48] demonstrated a reasonably good correlation between estimated WLM and the ^{210}Pb, of which a substantial fraction is retained in the body. ^{210}Pb is retained in bone longer than in any other body tissue. Lundin, et al.,[28] concluded that the concordance between WLM estimates from excess

^{210}Pb in bone and from exposure data used in the epidemiological study of lung cancer risk lends support to the validity of the quantitative nature of that study (Table 5).

In 1971, a standard of 0.3 WL or 4 WLM per year was promulgated by the U.S. Department of the Interior. Since that time additional analyses of the lung cancer mortality experience among these same U.S. white underground uranium miners by Archer, et al.,[35] (Table 6) and Wagoner[49] (Table 7) have documented an increasing public health problem of epidemic proportions.

Workmen's Compensation

Once the earlier predicted excess of lung cancer among miners of uranium bearing ores in the United States had been clearly documented, in 1962 and repeatedly confirmed in 1964, '65, '67, '68, '73, '76 and '79, it would have been expected that compensation under existing state workmen's compensation law would have promptly followed as a matter of natural cause. Such, however, was not the case as awarding of workmen's compensation was the subject of administrative injustice (restrictive statute of limitation and residency requirements) and scientific misrepresentations (specificity of histology and necessity of cigarette smoking).[50]

Histology of Lung Neoplasia

Early during the epidemiological study of United States uranium miners, Saccomanno, et al.,[51] demonstrated that the histologic cell type of bronchogenic carcinoma occurring among miners was markedly different from that experienced by the general population,, i.e., the small cell undifferentiated type was predominate. Again, in

1971, Saccomanno, et al.,[52] demonstrated that when contrasted with age-smoking-residents matched lung cancer controls, uranium miners experienced an increased relative frequency of small cell undifferentiated tumors. In addition, Saccomanno, et al.,[52] showed an association between radon daughter exposure and the increased proportion of bronchogenic tumors of the small cell undifferentiated histology, down to and including 40 - 200 WLM. These observations led some to speculate a specificity of radiation for small cell undifferentiated carcinoma of the lung and to invoke this as justification for denying workmen's compensation to uranium miners dying of lung cancer of a different histologic cell type. More recent, appropriate analysis by Archer, et al.,[53] (Table 8) in the United States and by Haracek, et al.,[54] and Kunz, et al.,[55] in Czechoslavakia using the rate approach has now demonstrated the fallacy of that logic by showing that epidermoid, small cell undifferentiated and adenomatous types are all increased among uranium miners. In addition, the earlier interpretation that the frequency distribution of histologic types of lung cancer among uranium miners varied markedly with radiation dose was shown to be an artifact resulting from "dilution" of radiogenic carcinomas by non-radiogenic carcinomas.[53]

Role of Cigarette Smoking

The early epidemiological study of white uranium miners in the United States not only had demonstrated an excess of respiratory cancer, but also a disproportionate relative frequency of small cell undifferentiated histology and an exposure-response relationship between radon daughter exposure and lung cancer risk, none of which were confounded by cigarette smoking. These early studies, however, did not clearly demonstrate an excess of lung cancer among American Indian uranium miners, who reported to use little or no tobacco.[28]

In addition, most lung cancer deaths among white uranium miners were among miners who had smoked cigarettes. These findings led some to speculate that the induction of an excess of bronchogenic cancer by radiation in the absence of cigarette smoking was unlikely or nonexistent. This speculative reasoning was the basis upon which many uranium miners who smoked were denied workmen's compensation. In 1971, however, Lundin, et al.,[28] hypothesized that if the latent period of radiogenic lung cancers were longer in nonsmokers as compared to smokers (due to the predominance of promoting agents in cigarette smoke) then it might be too early to expect many lung cancers among nonsmoking uranium miners, even though they may eventually have almost as great a risk of lung cancer as smokers who have had comparable radiation exposure. Wagoner, et al.,[56] in 1974 and Archer, et al.,[35] in 1976 tested that hypothesis by extending the study of lung cancer risk among American Indian uranium miners up to the period 1973-1974. These studies demonstrated (Table 9) a statistically significant excess of respiratory cancer with 11 deaths observed vs. 2.6 expected. As seen in Table 10, of the 11 deaths due to respiratory cancer among Indian underground uranium miners, 8 were of the small cell undifferentiated histology. Furthermore, four of the miners had never smoked cigarettes. Two only smoked 2-3 cigarettes/week, 4 only 2-6 cigarettes/day and only one smoked more than a half a pack per day. The mean induction-latent period was 20.5 years for those nonsmoking Indian uranium miners, and 17.1 years for those Indian miners who smoked lightly. This is in contrast to a mean induction-latent period of 13.7 years for 15 white uranium miners with lung cancer who smoked greater or equal to one pack of cigarettes daily. Similar excessive risks of

lung cancer have been demonstrated among nonsmoking miners exposed to radon daughers in Sweden[57], and in New Mexico.[58]

In 1979, Lundin, et al.,[59] reported a study of the estimated contribution of nonsmoking-nonmining, smoking and mining effects to the lung cancer risk of white underground uranium miners in the United States. The results of that study (Table 11) were supportive of the hypotheses that 1) lung cancers among uranium miners are initiated by irradiation and 2) cigarette smoking promotes the development of the lung cancers initiated by irradiation. Archer, et al.,[60] earlier reported that in contrast to the experience of the general population, cessation of cigarette smoking did little to decrease the respiratory cancer risk among uranium miners.

ADEQUACY OF 0.3 WL STANDARD

Lundin, et al.,[28] in 1971 demonstrated that the risk of respiratory cancer per unit of exposure (WLM) was greater in the lower cumulative radiation groups than in the higher ones. This finding led the authors t conclude that a reduction in radon daughter exposure from 12 to 4 WLM per year may not yield the same proportionate reduction in respiratory cancer as would be expected from a linear relationship, i.e., an assumption of linearity appears not to be conservative for exposure to radon daughters. On the basis of human, animal and theoretical data, the authors further concluded that there would appear to be no safety factor in a limit of either 7.5 or 2.5 WLM per year as the standard for uranium miners.[28]

In 1976, Sevc, et al.,[61] reported the study of lung cancer among miners of uranium-bearing ores who began underground mining in the Joachimsthal area of Czechoslovakia during the period 1948-1957. A

significant excess of lung cancer was demonstrated among uranium miners at each cumulative radiation exposure category down to and including 100 to 149 WLM. A doubling of the lung cancer risk was also demonstrated at approximately 50 WLM. The analysis by Seve and colleagues included all periods of time following initial underground mining as a single measure of lung cancer risk. The true excess lung cancer risk at 50 WLM, therefore, would be larger than twofold if consideration was restricted to the period 20 or more years since onset of exposure, a time period adjudged by the International Agency for Research on Cancer[62] to be associated with a relatively greater sensitivity for the detection of an occupational cancer risk. In 1978, Kunz, et al.,[63] comment on the likelihood of underestimating lung cancer risk at low exposure categories (< 120 WLM) as a result of wasted irradiation effects being inherent in the U.S. risk methodology. Lundin, et al.,[28] and Archer, et al.,[60] earlier had drawn attention to the fact that the methodology used to quantitate risk among U.S. uranium miners while ideal for situations in which the biological response to exposure was fairly prompt was misleading for latent disease such as lung cancer. These authors concluded that the U.S. methodology for quantitating risk would lead toward minimizing the risk of lung cancer in the lower exposure groups (<120 WLM) and while maximizing the risk in higher exposure groups.

Using chromosome aberrations as a biological dose-response indication of radiation effects, Brandom, et al.,[64] in 1978, demonstrated a significant association between increased aberration frequency and cumulative radon daughter exposure down to and less than 100 WLM. Following a review of data among uranium miners who were employed in Canada, Czechoslavakia, Sweden and the United States, the

National Academy of Sciences-National Research Council Committee on the Biological Effects of Ionizing Radiation concluded that the doubling dose for lung cancer could be even lower, i.e., at approximately 12 to 17 WLM of exposure.[65]

In 1976, the National Institute for Occupational Safety and Health recommended that it might be advisable to rotate long-term workers in high radon daughter exposure areas.[66] This recommendation was based on the judgment that the current standard of 4 WLM per year could not be characterized as safe since the risk of lung cancer would be expected to double after 10 to 20 years of employment. More recently, the Mine Safety and Health Administration posed the question as to whether or not the identification of a sputum sample as having moderately atypical cells would be sufficient to warrant the transfer of a uranium miner to another job category where the individual would realize a reduced radiation exposure. In response to that inquiry, Mason, et al.,[67] undertook a study of dynamic changes of sputum cytologic readings on uranium miners as a function of radiation exposure and cigarette smoking. As a result of that study, Mason and colleagues were of the opinion that the simplifying assumption of a systematic progression from less severe to more severe cytologic states prior to the definitive diagnosis of lung cancer is not tenable. The authors also found that the likelihood of a subsequent reading being less severe is non-trivial both among heavy smoking as well as nonsmoking uranium miners having 1627 WLM or more, each group experiencing exposures in excess of 0.3 WL at the time of sputum collection.

URANIUM MILLING

During the 1950's, uranium bearing ore, co[illegible]ining on the average less than 0.5 percent uranium oxide (U_3O_8) was [illegible]nt to mills where

it was stockpiled, crushed, sampled, ground and leached to extract the uranium. Extraction of uranium was accomplished either by a sulphuric acid leach or an alkaline carbonate leach method.[68] The final concentrate, commonly called "yellow-cake", was packaged in 55 gallon steel drums for shipment. During the milling of uranium bearing ore, appreciable airborne concentrations of the long-lived radioactive decay products or uranium are known to have been released. Those decay products of greatest concentration were ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra and ^{210}Pb.

What is known about the biological fate and consequence of these radioactive decay products? During the period 1960-1973, in both animals and humans, it was shown that whereas the bone tended to be the principal storage depot for radium and lead, the tracheobronchial lymph nodes were the sites of greatest concentration for inhaled uranium and thorium.[69-75] During the period 1965-1971, following prolonged exposure to uranium ore dust, radioactivity due to thorium in the tracheobronchial lymph nodes was shown to be 20 to 50 times greater than that due to ^{234}U or ^{238}U.[63, 76-77] During this same period of time, radiation had been implicated as a cause of malignant lymphoma following the atomic bomb explosions and therapeutic application.[78-79] Under these biological models, it was hypothesized that among uranium mill workers, the lymphatic system would be the most likely body organ for the induction of cancer by ^{230}Th. Archer, et al.,[80] in 1973 tested that hypothesis by studying the long-term mortality patterns among United States uranium mill workers. As shown in Table 12, during the period 1950 - 1967 only one cause of cancer category was found to be unusual among mill workers, that being malignant neoplasms of the lymphatic and hematopoietic tissue (other than leukemia) where four deaths were

observed as contracted with 1.02 expected, an excess significant at $p < 0.05$.

URANIUM WASTE

Whereas excessive risks of cancer have been demonstrated among workers mining and milling uranium-bearing ores, perhaps the largest potential public health problem can be found in the third phase of the uranium production industry, that area involving hazardous waste disposal. During the milling of uranium-bearing ores only a very small fraction of the ore and its radioactivity is recovered as U_3O_8 (yellow cake), the remaining portion ends up as liquid or solid waste. Tsivoglov and O'Connell[81] reported that in 1961, only 17,399 tons of uranium oxide concentrate were produced from approximately 8 million tons of uranium ores processed. The magnitude of the liquid waste volume produced by milling operations has been reported to vary according to the particular leaching process used, with acid leaching mills producing an average of 850 gals. per ton of ore, and alkaline leaching mills producing on the average 250 gals. per ton.[81] Since these wastes (both solid and liquid) contain radioactive decay products of radon, they are deposited and retained in tailings ponds and piles to prevent in theory environmental contamination. In reality, however, we know this was and is not the case.

In 1964, Tsivoglov[82] reported that the natural or background concentration of ^{226}Ra in surface water of the western United States has proved in the majority of the cases to be less than 0.1 pc/l. On occasion results as high as 0.8 or 1.0 pc/l have been found, and this has usually been associated with local uranium mining activities. In contrast, during the early days of uranium mining and milling in the United States (pre-1960), ^{226}Ra concentrations as high as 88 pc/l were detected at stream locations downstream from uranium mills.[82]

In like manner, ^{226}Ra content of sediments from streams of the western United States had been established at an average of 1.3 pc ^{226}Ra/gram of dry sediment. In contrast to this natural level, concentrations of ^{226}Ra as high as 2100 pc/gram were reported in one river. In another river, the Animas River, concentrations of ^{226}Ra in mud were 800 pc/gram immediately below the mill site and 100 pc/gram some forty miles downstream.

Mill tailings have also been documented to have been used as land fill for industrial and residential building sites and for road bed repair.

What can be said about the biological consequences of this pattern of uranium waste disposal? Uranium 238, uranium 234, and uranium 235, radium 226 and radium 228 are known bone seekers and do cause bone cancer. With regard to humans, the United States Public Health Service has estimated that drinking water containing 5 pc radium per liter would result in 150 millirem per year dose to the bone and thusly could be expected to be associated with 0.7 to 3 excess bone cancers per year per million people consuming such a concentration over their lifetime.

In 1978, the Uranium Mill Tailing Radiation Control Act was passed in the United States.[83] This act has as its purpose the protection of the public from waste tailings located at inactive uranium ore processing sites and future public exposures from mill tailings at active processing sites. The estimated cost for 20 inactive tailings sites has been estimated at $100 - $200 million and $5 - $6 million for each current mill site.[84] Regarding the potential for carcinogenesis secondary to public use or exposure to these waste tailings, Axelson and Edling[85] have recently demonstrated a significant association between lung cancer risk and residence in homes classifed to have elevated levels of radon and its daughters.

Because of concerns for an increased risk of lung cancer, the Surgeon General of the United States Public Health Service in 1970 issued guidelines for remedial action for dwellings constructed with or on uranium mill tailings.[86] These guidelines recommended that remedial action be initiated at indoor radon daughter concentrations of $\geq$ 0.01 WL, a condition not uncommon in the Colorado Plateau area. On the basis of additional data, the Environmental Protection Agency[86] has estimated that 110 - 230 extra lung cancer deaths would occur among a 100,000 population with a lifetime residency at ambient levels of radon daughter exposure, i.e., 0.004 WL. In contrast, 2000 - 3000 extra lung cancer deaths per 100,000 population were estimated to occur over a lifetime indoor radon daughter exposure rate of 0.02 WL.

FIGURE 1

THE URANIUM RADIOACTIVE DECAY SERIES

Isotope	Symbol	Half-life	Radiation
Uranium 238	^{238}U	$4.5X10^{9}$ yrs	alpha
Thorium 234	^{234}Th	24.1 days	beta, gamma
Protactinium 234	^{234}Pa	1.18 mins	beta, gamma
Uranium 234	^{234}U	$2.47X10^{5}$ yrs	alpha, gamma
Thorium 230	^{230}Th	$7.6X10^{4}$ yrs	alpha
Radium 226	^{230}Ra	1602 yrs	alpha, gamma
Radon 222	^{222}Rn	3.82 days	alpha
Polonium 218	^{218}Po	3.05 mins	alpha
Lead 214	^{214}Pb	26.8 mins	beta, gamma
Bismuth 214	^{214}Bi	19.7 mins	beta, gamma
Polonium 214	^{214}Po	$164X10^{-6}$	alpha
Lead 210	^{210}Pb	21.0 yrs	beta, gamma
Bismuth 210	^{210}Bi	5.0 days	beta
Polonium 210	^{210}Po	138.4 days	alpha
Lead 206	^{206}Pb	Stable	

DISTRIBUTION OF MINES AND MINERS BY RADON-DAUGHTER CONCENTRATIONS - 1952*

Radon daughters expressed in multiple of working level** (WL)	Mines		Mines	
	Number	(%)	Number	(%)
< 0.49	35	22.3	116	15.8
0.5 - 2.49	27	17.2	117	16.0
2.5 - 9.9	25	15.9	171	23.3
> 10	70	44.6	329	44.9
Total	157	100.0	733	100.0

* After Table II-3, Public Health Service (PHS) Publication 494, p. 4.
** Converted to WL of 1.3 x 10^5 MeV of alpha energy/liter of air.

TABLE 2

FRACTION OF MEN WORKING IN EACH RADIATION EXPOSURE GROUP

1952		1957	
Multiple of working level*	Percent of men*	Multiple of working level***	Percent of men**
< 0.5	15.8	< 0.5	8.2
0.5 - 2.49	16.1	0.5 - 1.9	24.3
2.5 - 10	23.4	2.0 - 9.9	44.2
> 10	44.7	10 and over	23.3

* 733 men
** 1690 men
*** 1.3 x 10^5 MeV of alpha energy per liter of air.

TABLE 3

SUMMARY OF THIRD QUARTER, 1962, RADON-DAUGHTER MEASUREMENTS

State	Mines reporting samples	Number of samples	Percent of mines in each working-level* range(1)			
			< 1	1 - 2.9	3 - 10	>10
Arizona	14	43	43	21	29	7
Colorado	207	600(2)	33	26	36	5
New Mexico	31	321	32	29	29	0
Utah	66	250(2)	27	44	26	3
Wyoming	9	90(2)	33	45	22	0
Total	327	1504	32	31	33	4

(1). Arithmetic average of mine samples used to determine mine rank, except for New Mexico where a weighted average of samples was used.
(2) Estimated
* 1.3 x 10^5 MeV of alpha energy per liter.

From: Holaday, D. A., and Doule, H. N. Environmental studies in the uranium mines. Radiological Health and Safety in Mining and Milling of Nuclear Materials. Vol. 1: 9-20. 1964.

TABLE 4

OBSERVED AND EXPECTED NONMALIGNANT RESPIRATORY DISEASE DEATHS ACCORDING TO TIME SINCE ONSET OF URANIUM MINING AMONG WHITE UNDERGROUND MINERS: JULY 1950-SEPTEMBER 1974

CAUSE OF DEATH	YEAR SINCE ONSET OF UNDERGROUND URANIUM MINING									
	<5		5-9.9		10-24.9		≥ 25		Total	
	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Nonmalignant respiratory disease ICD470-527	1	1.5	7	3.5	54	15.0	18	4.8	80	24.9

From: Archer, V. E., Gillam, J. D., and Wagoner, J. K. Respiratory disease mortality among uranium miners. N. Y. Acad. Sci. 271: 280-293. 1976.

TABLE 5

ESTIMATED CUMULATIVE WORKING LEVEL MONTHS FOR A SAMPLE OF STUDY GROUP MINERS DETERMINED FROM ^{210}Pb ASSAY OF BONE AS CONTRASTED WITH WLM USED IN CURRENT MORTALITY ANALYSES

Estimated cumulative WLM* used in current mortality analyses	Number of Study Group miners	Mean estimated WLM* from excess ^{210}Pb in bone	Standard error of mean
Less than 360	4	1,533.7**	1,327.8**
360 – 839	10	676.2	118.3
840 – 1799	12	1,309.8	317.6
1800 – 3719	14	2,696.0	489.2
3720 and over	11	3,098.0	744.3

* WLM estimated in uranium and other hard rock mines.

** One of the 4 miners in this category had 5,517 WLM estimated from excess ^{210}Pb in bone. The mean for the other 3 miners in this category was 206 WLM and its standard error was 11.1

From: Lundin, F. E., Wagoner, J. K., and Archer, V. E. Radon Daugher Exposure and Respiratory Cancer Quantitative and Temporal Aspects. NIOSH-and NIEHS Joint Monograph No. 1. National Technical Information Service. Springfield, Va. 1976.

TABLE 6

OBSERVED AND EXPECTED RESPIRATORY CANCER DEATHS

ACCORDING TO TIME SINCE ONSET OF URANIUM MINING

AMONG WHITE UNDERGROUND MINERS: JULY 1950-SEPTEMBER 1974

CAUSE OF DEATH	YEARS SINCE ONSET OF UNDERGROUND URANIUM MINING									
	<5		5-9.9		10-24.9		≥25		Total	
	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Malignant respiratory disease ICD 160-164	2	1.9	12	4.6	103	18.3	27	4.9	144	29.8

From: Archer, V. E., Gillam, J. D., and Wagoner, J. K. Respiratory disease mortality among uranium miners. N. Y. Acad. Sci. 271: 280-293. 1976.

TABLE 7

RESPIRATORY CANCER MORTALITY AMONG WHITE UNDERGROUND URANIUM MINERS

Period of Follow-Up	Obs.	Exp.	Relative Risk	Attributable Risk	Author
1950 - Dec. 1962	12	2.8	429	9.2	Wagoner, 1964
1950 - Dec. 1963	22	5.7	386	16.3	Wagoner, 1965
1950 - June 1965	37	7.4	500	29.6	Lundin, 1967
1950 - Sept. 1967	62	10.0	620	52.0	Lundin, 1969
1950 - Sept. 1968	70	11.7	598	58.3	Lundin, 1971
1950 - Sept. 1974	144	29.8	483	114.2	Archer, 1976
1950 - Dec. 1978	(205)	(40.0)	(510)	(164.0)	Wagoner, 1979

( ) = Estimates based upon incomplete follow-up.

From: Wagoner, J. K. Statement before Senate Special Committee on Aging. Grants, New Mexico, August 30, 1979.

TABLE 8

Relative Distribution of Histologic Types of Excess (Presumably Radiation-Induced) Bronchogenic Cancers

Radiation exposure groups (WLM)	Epidermoid (1A + 1B + 1C)		Small cell undifferentiated (2A + 2B)		Adenocarcinoma (3A + 3B + 3C)		Other types (4 + 5 + misc.)		Total
	Excess	Percent	Excess	Percent	Excess	Percent	Excess	Percent	Excess
1-359	0.94	8.7	8.27*	76.6	1.31	12.2	0.27	2.5	10.79*
360-1799	10.11	31.2	22.07*	68.1	0.13	0.4	0.08	0.3	32.39*
≥1800	10.68	21.5	33.69*	67.7	4.70*	9.4	0.68	1.4	49.75*
Combined groups	21.73	23.4	64.03*	68.9	6.14*	6.6	1.03	1.1	92.93*

* The observed numbers represented by these excess numbers are significantly different from the corresponding expected numbers ($p < 0.01$).

From: Archer, V.E., G. Saccomanno, & J. H. Jones. Frequently Of Different Histologic Types Of Bronchogenic Carcinoma As Related To Radiation Exposure. Cancer. 1974.

TABLE 9

Expected And Observed Deaths by Cause Among Indian Underground Uranium Miners, January 1960 Through December 1973.

Cause of Death	Expected	Observed
Tuberculosis, all forms	3.67	8
Malignant neoplasms , all	9.89	17
Digestive systsm	3.83	4
Respiratory system	2.58	11+
Other & Unspecified sites	3.48	2
Cardiovascular renal disease	25.34	3+
Voilent deaths	41.38	44
All other known causes	43.52	28
Unknown causes**	0.00	7
Total	123.80	107

** Decedents for whom death certificates were not obtained.
+ Significant at 1% level.

From: Archer, V. E., Gillam, J. D., and Wagoner, J. K. Respiratory disease mortality among uranium miners. N.Y. Acad. Sci. 271: 280-293. 1976.

TABLE 10

Underground Indian Uranium Miners Who Have Died From Respiratory Cancer

Cigarettes		Histologic		Latent	Age at
Average	Years	Cell Type*	WLM	Period	Death
2-3/day	15	2A	782	19	44
0	0	2B	867	17	42
2-3/week	30	2A	1325	14	55
0	0	2B	1336	23	60
2-3/week	20	2B	1415	15	56
10-20/day	29	2B	2038	15	45
3-4/day	3	2A	2039	20	40
3-6/day	50	1A	2760	24	60
0	0	-	3052	21	39
0	0	-	3202	21	43
3-6/day	15	2B	3234	17	35

*Histologic Cell Types: 1A is well differentiated epidermoid 2A is oat cell,
2B is small round cell or polygonal undifferentiated,
5 is mixed adeno-epidermoid and and 6 is other.

From: Archer, V. E., Gillam, J. D., and Wagoner, J. K. Respiratory disease mortality among uranium miners. N. Y. Acad. Sci. 271: 280-293. 1976.

TABLE 11

OBSERVED NUMBER OF LUNG CANCER DEATHS, TOTAL RATES AND ESTIMATED RATES FOR NON-SMOKING NON-MINING, SMOKING AND MINING EFFECTS BY CIGARETTE SMOKING CLASSIFICATION, OCTOBER 1960 THROUGH SEPTEMBER 1968

Cigarette Smoking Classification	Number of Lung Cancer Deaths	Rates per 10,000 person-years			
			Estimated Components		
		Observed	Non-Smoking Non-Mining*	Smoking**	Excess Over Expected***
Non-Smokers	2	6.5	1.7	0	4.8
Former Smokers	5	42.1	1.9	0.7	39.5
Smokers of ≤ 1 Pack Daily	38	41.0	1.3	5.7	34.0
Smokers of > 1 Pack Daily	17	51.2	1.1	26.6	23.4
Total	62	36.7	1.4	8.4	27.0

*Based on non-smoking rates specific for age and calendar year.
**Based on indirect standardization for age and calendar year minus non-smoking rates.
***Based on excess of observed rates over expected rates standardized for age and calendar year.

From: Lundin, F. E., Archer, V. E., and Wagoner, J. K. An exposure-time-response model for lung cancer mortality in uranium miners-effects of radiation exposure, age and cigarette smoking. Energy and Health (Breslow, N. E. and Whittemore, A. S., Eds.). Society for Industrial and Applied Mathematics, Phil., Pa., 243-264. 1979.

TABLE 12

Observed And Expected Deaths Due To Cancer Among Uranium Mill Workers, 1950 - 1967

Cause Of Death	Obs.	Exp.	SMR
All Malignant neoplasms	20	18.11	110
Digestive system	4	5.06	79
Respiratory system	4	4.26	94
Leukemia & aleukemia	1	0.79	127
Lymphatic & Lematopoietic tissue other than leukemia	4	1.02	392+
Other & unspecified	7	6.98	100

+ Significant at $p < 0.05$.

From: Archer, V. E., Wagoner, J. K. and Lundin, F. E. 1973. Cancer mortality among uranium mill workers. Journal of Occupational Medicine 15: 11-14.

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International Conference

RADIATION HAZARDS IN MINING: CONTROL, MEASUREMENT, AND MEDICAL ASPECTS

October 4-9, 1981
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Published by
Society of Mining Engineers
of
American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc.
New York, NY • 1981

EXHIBIT 2

Chapter 123

Mortality Follow-up Through 1977 of the White Underground Uranium Miners Cohort Examined by the United States Public Health Service

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Introduction

Since excess lung cancer mortality was first noted in the late 1800's among Joachimsthal-Schneeberg miners, there have been a number of studies of the long term health effects among various types of miners exposed to elevated levels of radon and its radioactive decay daughters. Substantial excesses of lung cancer have been noted among miners in the Joachimsthal mines (Sevc, 1976), lead-zinc miners in Sweden (Axelson, 1979), fluorspar miners in Canada (DeVilliers, 1971), iron miners in Sweden (Renard, 1974), uranium miners in Canada (Hewitt, 1976), and metal (Wagoner, 1963) and uranium miners in the United States (Lundin, 1971; Archer, 1976).

The latter prospective cohort has also been shown to be at an excess risk of death due to tuberculosis, nonmalignant respiratory disease, and accidents when followed through September 30, 1974 (Archer, 1976). This report extends the followup of this cohort of miners through December 31, 1977 and expands the mortality analysis to investigate more cause-specific categories.

Methods

During the decade beginning with July, 1950, medical teams from the United States Public Health Service (USPHS) examined 3362 white and approximately 780 nonwhite males who had worked underground in uranium mines in the Colorado Plateau at least one month by January 1, 1964. Occupational, medical, and smoking histories were obtained during the examinations and often updated/confirmed during subsequent annual censuses of the miners conducted by the USPHS.

The white miners now have been followed-up through December 31, 1977 using the Social Security Administration, Internal Revenue Service, direct telephoning and various other sources. Death certificates were obtained for the deceased and coded directly into the Seventh Revision of the International Classification of Diseases, Adapted, using the rules in effect at the time of death. Deceased miners for whom no certificate has yet been located were assumed dead on the date specified by the reporting agency, cause of death unknown.

The uranium miners cohort was analyzed using a modified life-table system developed by the National Institute for Occupational Safety and Health (NIOSH). Person-years at risk of dying (PYAR) were calculated for each miner from his first USPHS medical examination date or date upon completion of one month of underground uranium mining if that was later.

PYAR were calculated specific for five-year age groups, calendar periods, and periods after first underground uranium mining. The numbers of cause-specific observed deaths among the cohort occurring by December 31, 1977 were compared to the numbers of expected deaths. The expected deaths were calculated by multiplying the appropriate PYAR by the United States death rates for white males specific for five-year age groups, five-year calendar periods, and cause. The results were summed over the age and calendar period specific categories to obtain the total expected deaths for each cause.

Standardized Mortality Ratios (SMR's) were calculated for each cause by dividing the observed number of deaths by the expected number of deaths and multiplying by 100. In some tables, two-sided 95% confidence intervals for the SMR's were computed using either Fisher exact confidence limits, if the observed frequency was less than eight, or approximate confidence limits, if the observed frequency was eight or greater, to indicate statistical significance. Because a priori hypotheses had been well established, one-sided lower confidence limits were used for tuberculosis, lung cancer, other nonmalignant respiratory disease (ONMRD), accidents, and total mortality.

Results

The cohort included 589 miners first examined in either 1950, 1951 or 1953; 753 first examined in 1954; 1235 first examined in 1957; 5 first examined in 1958; and 782 first examined in 1960. In Figure 1 the distribution of the cohort by first year of underground uranium mining indicates that 13.7% started before 1947 and would have thus had an opportunity to be followed beyond 30 years

FIG. 1 DISTRIBUTION OF FIRST YEAR EMPLOYED AT URANIUM MINING FOR WHITE MALE MINERS

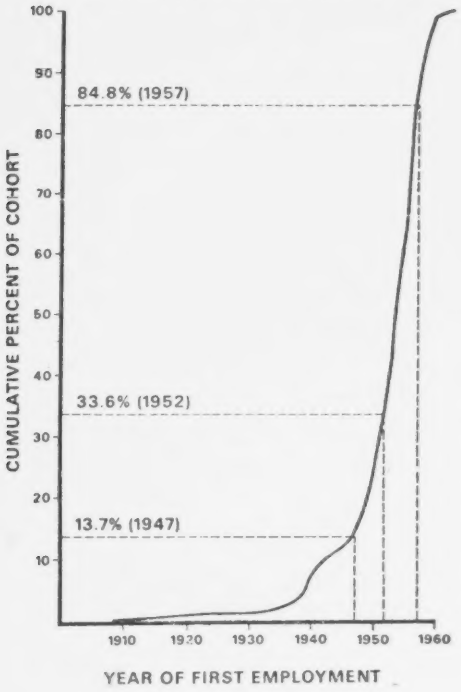
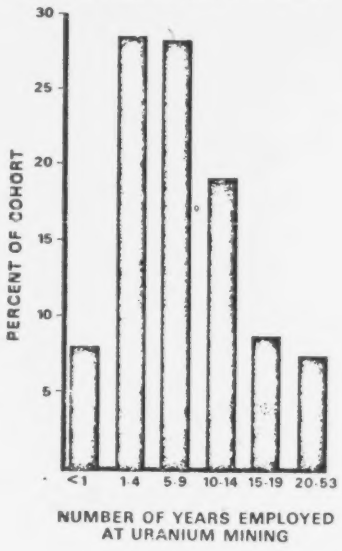


FIG. 2 DISTRIBUTION BY NUMBER OF YEARS EMPLOYED AT URANIUM MING FOR WHITE MALE MINERS



since first underground experience. Fifty-one percent of the cohort was hired between 1952 and 1957. By 1977 these men had reached a 20-25 year induction-latency period. Turnover was substantial (Figure 2); the majority of miners having worked less than 10 years in uranium mines. The median age at first uranium mining was 30.

Follow-up of the white underground miners resulted in only three persons untraced (Table 1) and the identification of 950 deaths. Death certificates are still outstanding for 33 (3%) of the deceased, 5 of whom died before 1970, 13 between 1970-1974, and 15 after 1974. Only 4 of these 33 deaths occurred after 25 years since start of underground uranium mining. The cohort, whose average cumulative dose of radiation from radon daughters was 821 Working Level Months (median = 430 WLM), was followed up an average of 19 years, generating 62,556 person years at risk.

Observed and expected deaths for 87 causes of death were examined; some of those with small numbers are not reported, leaving the 51 causes in Table 2. Overall, 950 deaths were observed, producing an SMR of 158 among these miners. Among these 950 deaths were approximately 50 who died before September 30, 1974 yet presumably were lost-to-follow-up at the time of the previous report (Archer, 1976) and were thus reported as such, ie. included in the total of 60 then untraced.

The excess risk of tuberculosis (SMR=409) is based on 14 observed deaths. These are substantially more deaths due to this cause than the three reported by Archer and appear to be due to a nosology error in the 1976 report. Ten of the 14 death certificates mentioned silicosis or silicotuberculosis. Nine of the 14 cases had prior hardrock mining experience, over 10 years for six of them. However, one case of silicotuberculosis had only prior coal mining experience while two others had no prior mining experience at all.

A two-fold risk of death due to all malignant neoplasms was noted. No deaths due to buccal cavity, pharyngeal, or nasal cancer were observed. A five-fold excess was noted for cancer of the trachea bronchus, and lung, subsequently referred to as lung cancer. Using the formula for attributable risk, it appears that 80% of the deaths due to lung cancer in this cohort were attributable to uranium mining. Elevated risks of

death due to stomach, pancreatic, prostate, and skin cancer were noted for the first time among this cohort, although none were statistically significant. Pathology reports have been requested on persons who died from these malignancies according to their death certificates. Some reports have been received. For three cases whose death certificates read pancreatic cancer and one whose certificate read stomach cancer, the pathology report indicated primary lung cancer. Another whose death certificate stated pancreatic cancer was actually a primary malignancy of the bile duct.

Although other studies of persons exposed to radiation have found associations with increased risks of leukemia, lymphoma, multiple myeloma, and cancer of the colon, liver, brain, and thyroid, no excesses due to these causes were evident. One case of breast cancer and one of bone cancer were observed.

In contrast to the deficit of deaths due to cirrhosis, a statistically significant twofold excess of death due to alcoholism was found. No excess of deaths due to circulatory system disease occurred; in fact, the SMR of 86 indicated the existence of a healthy worker selection for this occupational cohort. Despite this overall deficit, excess risks were evident for three subcategories of heart disease, namely, rheumatic fever, chronic rheumatic heart disease, and "other" heart disease.

The excess risk of nonmalignant respiratory disease, when examined in this update by cause, appeared to be limited to a two-fold excess of bronchitis and a five-fold excess of "other nonmalignant respiratory disease". The latter consisted mainly of silicosis, emphysema, and fibrosis. The nonsignificant excess of observed deaths due to diseases of the stomach and abdomen were all (six) due to ulcers. The excess mortality from accidents was not limited to any single type of accident but appeared to be greatest for "other" or miscellaneous accidents, many of which were work related. In fact, more excess deaths occurred among miners due to "other accidents" than due to "other nonmalignant respiratory disease".

Perhaps the most important new finding was the statistically significant excess of mortality due to chronic nephritis and renal sclerosis. Upon further investigation of these deaths due to kidney disease, (Table 3), one of the death certificates mentioned proximal renal tubular degeneration, an unusual kidney disease that has been induced experimentally in animals exposed to uranium. Two of the certificates mentioned glomerulonephritis (or Bright's disease). A third case died from Goodpasture's syndrome, an immunologically mediated glomerulonephritis. This case is included in the case listing but not in the computation of SMR's since its ICDA code falls into a non-renal category. For case number 9, systemic silicosis was mentioned on the death certificate. Two of the cases also had worked for three years each in uranium mills. All of these deaths occurred in the period 1962 - 1973 with a median of 17 years since first underground uranium employment. All but two cases first worked underground after 1950.

Indicated in Table 4 are the temporal changes in risk for selected causes of death. The excess of deaths due to lung cancer, in both the relative and absolute sense, appears to have peaked during 1965-1974. The excess mortality due to "other NMPD" exists in all time periods and a well defined unimodal curve is not evident. Excess deaths due to chronic nephritis and renal sclerosis have so far only been identified from 1960-1974. The excess risk of accidental deaths has declined since the late 1950's, but still remains elevated two-fold.

In an attempt to account for the strong healthy worker effect that often occurs in the first years after initial employment in an industry and in order to account for the induction-latency period of certain chronic diseases, mortality was examined by time after first uranium mining (Tables 5 & 6). No notable trends were seen for the majority of diseases. However, a greater relative excess after 10 years since first uranium mining did exist for nephritis. Further investigation of the relative risk of death due to chronic nephritis after 10 years induction-latency had elapsed revealed a sharp increase with duration of underground mining. There were 2 observed and 0.9 expected deaths below 5 years duration of underground uranium mining, 2 observed and 0.6 expected deaths from 5-9 years duration, and 3 observed versus 0.5 expected for 10 or more years duration.

The SMR's for deaths due to tuberculosis and accidents decreased from the shorter to the longer induction-latency periods. The SMR's for both lung cancer and ONMRD were strongly associated with the induction-latency periods beyond 4 years in Table 6. They peaked beyond 25 years since first uranium mining. Despite the increased observation period since the previous report, no lung cancer cases occurred among miners with less than 300 WLM..

Before age 50, these miners experienced a two-fold risk of total mortality (Table 7). The major components of this excess risk were lung cancer and accidental mortality. The SMR's for all-causes decreased with age. Most of the decline was due to decreasing risks of death from lung cancer, accidents and ONMRD.

Table 1

Vital Status of Cohort of White Uranium Miners

	Number	Percent
Alive	2409	72
Deceased	950	28
Certificate Obtained	917	97
Certificate Outstanding	33	3
Lost to Follow-up	3	0.1
Total	3362	100

Table 2

Cause-Specific Mortality Among a Cohort of White Male Uranium Miners Followed Through December 31, 1977

CAUSE OF DEATH	ICDA* (7th Rev.)	OBSERVED	EXPECTED	SMR	95% Confidence Intervals**
Tuberculosis	(001-019)	14	3.4	409	247-
All Malignant Neoplasms	(140-205)	264	117.2	225	199-254
Buccal Cavity and Pharynx	(140-149)	0	4.0	0	
Esophagus	(150)	2	2.8	72	9-260
Stomach	(151)	9	6.0	150	68-284
Intestines including Colon	(152,153)	7	10.2	69	28-141
Rectum	(154)	1	3.7	27	1-150
Liver and Biliary Tract	(155,156A)	2	2.8	71	9-256
Pancreas	(157)	9	6.6	137	63-260
Larynx	(161)	0	1.9	0	
Lung	(162,163)	185	38.4	482	425-
Breast	(170)	1	0.2	453	14-1081
Prostate	(177)	7	5.9	118	47-243
Kidney	(180)	1	3.0	33	1-184
Bladder	(181)	3	3.2	94	19-274
Skin	(190,191)	5	2.3	216	70-504
Brain Tumors	(193,223,237)	4	5.3	75	21-193
Thyroid	(194)	0	0.3	0	
Bone	(196)	1	0.6	153	4-877
Lymphatic & Hematopoietic	(200-205)	9	12.0	75	34-142
Lymphosarcoma and Reticulosarcoma	(200)	2	3.7	55	7-198
Hodgkins Disease	(201)	1	1.8	55	1-305
Leukemia	(204)	5	4.8	104	34-243
Other Hematopoietic and Lymphatic Malignancies	(202,203) 205)	1	1.7	58	1-324
Diabetes Mellitus	(260)	4	8.5	47	13-121

CAUSE OF DEATH	ICDA* (7th Rev.)	OBSERVED	EXPECTED	SMR	95% Confidence Intervals**
Alcoholism	(322)	7	2.6	273	110-563
Vascular Lesions Affecting Central Nervous System	(330-334)	25	36.6	68	44-101
Diseases of the Circulatory System	(400-468)	233	266.6	87	77-99
Rheumatic Fever	(400-402)	2	0.2	1093	132-3948
Chronic Rheumatic Heart Disease	(410-416)	11	6.1	181	90-324
Arteriosclerotic Heart Disease	(420)	167	220.9	76	65-88
Other Heart Disease	(421-434)	28	16.4	171	113-247
Nonmalignant Respiratory Disease	(470-527)	103	31.6	324	265-393
Acute Upper Respiratory Infection	(470-475)	0	0.1	0	
Influenza	(480-483)	0	0.8	0	
Pneumonia	(490-493)	15	12.1	124	69-204
Bronchitis	(500-502)	5	2.1	235	76-548
Other Respiratory Diseases	(510-527)	83	16.6	499	413-
Diseases of Stomach & Abdomen	(540,541,543)	6	4.6	130	48-284
Hernia & Intestinal Obstruction	(560,561,570)	4	2.1	192	52-493
Cirrhosis	(581)	14	18.1	77	42-130
Acute Nephritis	(590)	0	0.3	0	
Nephritis with Edema including Nephrosis	(591)	1	0.3	388	10-2161
Chronic & Unspecified Nephritis and Renal Sclerosis	(592-594)	8	3.1	262	113-516
Kidney Infection	(600)	0	1.4	0	

CAUSE OF DEATH	ICDA* (7th Rev.)	OBSERVED	EXPECTED	SMR	95% Confidence Intervals**
Accidents	(800-962)	155	46.8	331	289-
Transportation	(800-864)	47	26.4	178	131-237
Poisoning	(870-895)	5	1.9	258	84-604
Falls	(900-904)	10	4.7	215	103-387
Other Accidents	(910-936, 960-962)	91	12.9	707	569-868
Suicides	(963, 970-979)	24	16.0	150	96-223
Homicides	(964, 980-989)	4	4.9	82	22-211
Residual+		40	29.1	137	98-187
Unknown Cause		44**	7.1	620	450-832
TOTALS		950	600.3	158	150-

Note:
+Residual: calculated by subtraction of the major groupings from all causes.
*International Classification of Diseases, Adapted
**Includes 33 death certificates not yet obtained
++Lower Limit for one-tailed test or lower and upper limits for two tailed test

Table 3

Deaths Due to Chronic Nephritis and Renal Sclerosis Among Uranium Miners

Case	7th Rev. ICDA	Death Certificate Diagnosis	FDU*	DurU*	CWLM	Age	DOD	Latency	Significant Other Work
1	456	Uremia, Goodpastures syndrome (4 mos.)	7/52	11-11	1076	35	8/68	16	Copper smelter 1952
2	592	ALG for renal failure (1 yr)	7/51	1-4	298	36	10/69	18	Uranium mill, 1955-1958
3	592	Glomerular nephritis old progressive (25 yrs)	2/59	7-8	1378	41	6/70	11	
4	593	Bright's Disease (4 yr.)	5/51	11-11	1145	45	2/71	20	Gold, Lead, Zinc, 1943+
5	593	Acute reaction & removal of renal graft (7 days)	7/53	11-4	1486	46	4/73	20	
6	593	Chronic renal failure (1 yr)	11/59	0-9	119	51	5/63	4	Lead, zinc, copper, gold miner, 1946-9
7	591	Subacute glomerular nephritis (7 mos.)	3/57	4-3	579	55	8/63	6	molybdenum miner 1939+, Blacksmith 1951+
8	594	Uremia, proximal renal tubular degeneration (mos.)	7/57	8-11	895	62	11/67	10	Tungsten & other HR mining, 1930+
9	593	Emphysema, pulmonary fibrosis, silicosis (10 yrs.) renal & cardiac failure (60 days) Uremia (30 days)	7/26	1-0	244	65	8/62	36	Uranium mill leacher, 1946-9
10	592	Acute renal failure DC Chronic renal disease congestive heart failure (cor pulmonale), 3rd stage silicosis	7/40	16-6	2413	72	1/69	29	

*FDU= First date underground uranium mining
+DurU= Duration of underground uranium mining experience

Discussion

Despite the probable existence of an underlying selection of relatively healthy persons into uranium mining as indicated by the low SMR for cardiovascular disease, there is no overall deficit of mortality or "healthy worker effect" as seen in most working groups. In fact the overall risk of death is 1.58 times that of United States white males. This is one of the highest risks of mortality reported in a working population, ranking about even with asbestos workers. A number of causes of death contribute to this excess, the most overwhelming being lung cancer, accidents, and nonmalignant respiratory disease -- all three previously recognized (Archer, 1976; Lundin, 1971). If regional lung cancer rates had been used for comparison instead of U.S. rates, the excess risk of lung cancer would have been even higher.

While the nephrotoxicity of uranium has been documented repeatedly in animals (Voeghtlin, 1949), excess mortality from renal disease has not been reported previously among occupationlly exposed workers. It is unclear whether the overall observed three-fold excess of deaths due to chronic nephritis and renal sclerosis in this cohort is due to exposures to the uranium ore, to other exposures associated with mining, or to non-occupational risk factors. Although one death certificate mentioned renal tubular degeneration, the characteristic kidney lesion induced by uranium, renal toxicity from uranium would not be expected to occur among miners. This is because much of the uranium dust in mines occurs as oxides which are relatively insoluble; such compounds are cleared only slowly through the kidneys. Two of the cases had worked in uranium mills where they could have been exposed to "yellowcake" (ammonium diuranate), a more soluble and thus more nephrotoxic form of uranium. Five of these cases had occupational histories involving mining or smelting other metals, potentially exposing them to other nephrotoxins such as lead, gold and cadmium. Chronic renal failure is also a reported but unusual complication of silicosis (Hauglustaine, 1980). In fact, the association of nephrotoxicity with mining may extend well beyond uranium mines. Statistically significant excess risks of death due to kidney disease have recently been reported among miners in general both in Washington State (Milham, 1981) and in the United Kingdom (Registrar General, 1978).

Pancreatic and skin cancer have been previously associated with radiation exposure (Mancuso, 1977; Sevcova, 1978). Mortality rates for these malignancies as well as lung cancer among white males in the 4 state area of the Colorado Plateau are generally lower than for the U.S. (Mason, 1974). Thus, use of U.S. rates for comparison underestimates the risk. However, the excesses of pancreatic and skin cancer found in this study did not show any concentration after 10 years since first uranium mining. Furthermore, of the seven deaths due to pancreatic cancer (according to the death certificate) that occurred after 10 years latency, three were actually misdiagnosed primary lung cancers. This is a much more frequent misdiagnosis of lung cancers to this cause than the 1% reported elsewhere (Percy, 1981). Therefore, the apparent excess of pancreatic cancer may, in reality, be a manifestation of the excess risk of

Observed (OBS) and Expected (EXP) Deaths Due to Selected Causes Among White Underground Uranium Miners by Calendar Time — Table 4

Years		Tuberculosis (01-19)+	Lung Cancer (162,163)	Other NMRD (510-527)	Chronic & Unspecified Nephritis (592-594)	Accidents (800-962)	All Causes
1950-4	OBS	1	0	1	0	5	11
	EXP	0.3	0.3	0.1	0.2	1.6	10.9
	SMR*	333	0	1000	0	313	101
	95% CI*	15	--	46	--	122	57
1955-9	OBS	2	6	5	0	36	94
	EXP	0.8	2.2	0.8	0.6	7.1	55.1
	SMR	250	273	625	0	507	171
	95% CI	46	116	259	--	375	143
1960-4	OBS	5	23	14	2	52	184
	EXP	0.9	5.4	2.1	0.8	11.2	108.1
	SMR	555	426	667	250	464	170
	95% CI	219	291	403	30-896	364	150
1965-9	OBS	5	51	17	3	25	214
	EXP	0.7	8.8	3.8	0.7	11.7	144.2
	SMR	714	580	447	429	214	148
	95% CI	276	453	282	85-1204	148	132
1970-4	OBS	1	70	34	3	26	294
	EXP	0.5	12.5	5.6	0.5	10.1	171.0
	SMR	200	560	607	600	257	172
	95% CI	11	455	447	121-1710	180	156
1975-7	OBS	0	35	12	0	11	153
	EXP	0.2	9.2	4.2	0.3	5.0	111.0
	SMR	0	380	286	0	220	138
	95% CI		283	164	--	123	120

+ Seventh Revision, International Classification of Diseases, Adapted Code
*Standardized Mortality Ratio and 95% Confidence Interval (Lower limit for one-tailed test or lower and upper limits for two-tailed test)

Observed (OBS) and Expected (EXP) Deaths Due to Selected Causes By Years After First Uranium Mining Among White Underground Miners — Table 5

Cause of Death	ICDA* (7th Rev.)	<10 Years OBS	<10 Years EXP	<10 Years SMR	≥10 Years OBS	≥10 Years EXP	≥10 Years SMR
Tuberculosis	(1-19)	7	1.4	500	7	2.0	350
All Malignant Neoplasms	(140-205)	28	21.9	128	236	95.3	248
Stomach	(151)	2	1.4		7	4.6	152
Liver	(155,156A)	0	0.6		2	2.3	
Pancreas	(157)	2	1.2		7	5.4	130
Prostate	(177)	0	0.6		7	5.3	132
Skin	(190-191)	1	0.5		4	1.8	
Brain Tumors	(193,223,237)	0	1.4		4	3.9	
Alcoholism	(322)	1	0.6		6	2.0	300
Chronic & Unspecified Nephritis & Other Renal Sclerosis	(592-594)	1	1.1		7	1.9	362
Accidents	(800-962)	81	17.5	463	74	29.3	253
All Causes		194	128.6	151	756	471.7	160

*International Classification of Diseases, Adapted
+Standardized Mortality Ratio

Table 6

Observed and Expected Deaths Due to Respiratory Diseases
By Years After First Uranium Mining Among White Underground Miners

Cause of Death		Year After Start of Underground Uranium Mining 0-4	5-9	10-24	25-29	30-34	≥35	Total
Lung Cancer	OBS	2	12	129	20	12	10	185
(ICDA, 162-163)	EXP	1.8	4.3	25.3	2.8	1.8	2.5	38.4
	SMR	111	279	510	714	667	400	482
	95% CI	20	159	438	480	390	217	425
Other Non-malignant	OBS	0	5	55	9	9	5	83
Respiratory Diseases	EXP	0.6	1.6	10.9	1.3	0.8	1.4	16.6
(ICDA, 510-527)	SMR	--	312	505	692	1125	357	500
	95% CI		122	398	368	591	136	413

*Standardized Mortality Ratio and 95% Confidence Interval (Lower Limit for one-tailed test or lower and upper limits for two-tailed test)

Table 7

Observed and Expected Deaths Due to Selected Causes Among
White Underground Uranium Miners by Age

Years		Tubercu-losis (01-19)	Lung Cancer (162,163)	Other NMRD (510-527)	Chronic & Unspecified Nephritis (592-594)	Accidents (800-962)	All Causes
<50	OBS	4	44	10	4	117	289
	EXP	1.2	5.9	1.6	1.3	29.4	144.9
	SMR*	344	751	645	315	397	199
	95% CI*	117	575	350	86-807	339	181
50-64	OBS	6	106	49	3	32	444
	EXP	1.6	21.7	7.8	1.2	13.2	275.6
	SMR	365	489	631	257	243	161
	95% CI	159	414	490	53-752	177	149
65+	OBS	4	35	24	1	6	217
	EXP	0.6	10.9	7.3	0.6	4.2	179.8
	SMR	649	321	328	161	144	121
	95% CI	222	237	226	4-895	63	108

+ Seventh Revision, ICDA Code
* Standardized Mortality Ratio and 95% Confidence Interval (Lower Limit for one-tailed test or lower and upper limits for two-tailed test)

small cell undifferentiated lung cancer among uranium miners together with the relatively advanced stage of the disease at which the cases first seek medical care. The excess of skin cancer among Czechoslovakian uranium miners reported by Sevcova was predominantly basal cell carcinoma. However, four of the five deaths in this study due to skin cancer were melanomas according to the death certificates. Other known radiosensitive site specific malignancies were not in excess with the obvious exception of lung cancer. Radon daughters attached to nonrespirable dust particles would be expected to settle in the nose and nasal pharyngeal regions, yet no malignancies of these sites were found.

The SMR for lung cancer appears to be dropping over the last 3 years compared to earlier periods even after accounting for missing death certificates. However, it is not known if this trend would persist if the lower regional mortality rates were used for comparison instead of U.S. rates. Regardless, for purposes of standard setting and of understanding human carcinogenesis, it is imperative that these miners continue to be followed to determine if this decrease in risk is real.

The substantial excess risk previously noted for NMRD is now seen to exclude influenza, pneumonia, and acute upper respiratory infectious disease mortality. It appears to have peaked before 1975, even after accounting for unobtained death certificates. Mortality risk from accidents although still elevated, has continued its decline since the late 1950's. This latter phenomenon is probably due to the fact that the accidential deaths on the job are less common as the cohort members become acclimated to the underground environment or as they gradually drop out of the underground mining workforce and work elsewhere or retire. In fact, as of 1968, only 11% of the cohort were known to still be mining uranium.

One methodologic issue noted from this update is the importance of determining the vital status of the last few members of a cohort. In this case, the previous report left only 60 members, or 2% of the cohort, lost to follow-up, yet approximately 50 of them eventually were discovered to have died before the end of the previous follow-up period. If these deaths had been included in the previous report the all-causes SMR would have been increased by approximately 7%. The distribution of these additional deaths by cause would have increased some cause-specific SMR's even more. Similarly, in this report, certain cause-specific SMR's would increase once the 33 missing death certificates are obtained.

Future analysis will include follow-up of the Indian miners, and incorporation of WLM dose data, smoking data, and regional mortality rates.

Acknowledgements

The authors would like to acknowledge the dedicated followup efforts of Mrs. Isabel Nelson, Mrs. Laurel Miller, Mrs. Edith Dodd, Ms. Clorinda Battaglia, Ms. Judy Bachmann, Ms. Mary Hogan and their staffs, and we also would like to acknowledge the exceptional assistance in manuscript preparation by Ms. Patricia Fitzpatrick and Ms. Cathy Aranyos.

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Lung Cancer Among Navajo Uranium Miners*

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Lung cancer has been a rare disease among the Indians of the southwestern United States. However, the advent of uranium mining in the area has been associated with an increased incidence of lung cancer among Navajo uranium miners. This study centers on Navajo men with lung cancer who were admitted to the hospital from February 1965 to May 1979. Of a total of 17 patients with lung cancer, 16 were uranium miners, and one was a nonminer. The mean value of cumulative radon exposure for this group was 1139.5 working level months (WLMs). The predominant cancer type was the small cell undifferentiated category (62.5 percent). The low frequency of cigarette smoking in this group supports the view that radiation is the primary cause of lung cancer among uranium miners and that cigarette smoking acts as a promoting agent.

The association between uranium mining and lung cancer is well established today. The relationship between lung disease and mining was recognized in European studies as early as the 16th century.[1] Subsequent reports confirmed those early observations and attributed pulmonary malignancies to high radiation levels found in the mines.[2,3]

With the onset of intensive uranium mining in the United States in 1946, a similar risk of lung cancer associated with radiation was suspected. The risk was especially enhanced when excessive radon concentrations existed in the mine air.[4] Other research data on the miners have indicated that their risk of lung cancer is related to the magnitude of exposure to radon daughters.[5,6] Moreover, a recent study clearly demonstrated an excess of lung cancer among the white and Indian uranium miners of the southwestern United States.[7]

Numerous reports have largely attributed the etiology of lung cancer among uranium miners to radiation.[7,8] Another study, however, has suggested that the leading cause of lung cancer in uranium miners is cigarette smoking, since the incidence of lung cancer in noncigarette smokers is "insignificant."[9]

To cast more light on the controversy of cigarettes vs radiation in the causation of lung cancer, a number of Navajo uranium miners were studied, since they represent a singular group who smoked few cigarettes and had a very low rate of lung cancer before the advent of uranium mining.

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Reprinted from CHEST
Vol. 81, p. 449-452, April 1982 Issue

Materials and Methods

The Shiprock Indian Health Service Hospital and the Navajo Family Health Center are situated in the Four Corners area (New Mexico, Arizona, Utah, and Colorado). These facilities provide medical care to approximately 25,000 Navajos. This population includes many former and present uranium miners.

All male Navajo miners and nonminers with lung cancer admitted to the hospital between February 1965 and May 1979 constitute the basis for this report. Verification of occupation, radiation exposure records, and time spent in the mines was furnished by the National Institute for Occupational Safety and Health and the Center for Disease Control at Salt Lake City. Smoking histories were obtained from patients' charts. Diagnosis of lung cancer and cell type were established by biopsy, bronchoscopy, thoracotomy, or autopsy. The induction-latent period (time from onset of mining to diagnosis of cancer) was determined for each miner. Age at and date of death were obtained from hospital records and death certificates.

Data on cumulative radon daughter exposure are expressed as working level months (WLMs). One working level (WL) is equivalent to 1.3×10^5 MeV of potential a energy from radon daughters per liter of mine air. WLMs are the cumulative underground exposure in working months (170 hours) times concentration of radon daughters in WL specific for mine and calendar year.

Results

Tables 1 and 2 summarize the data for each miner. Of the 17 male Navajo patients with lung cancer admitted during the period February 1965 to May 1979, 16 (94.1 percent) were uranium miners; one (5.8 percent) was a nonminer (a former carriage-maker). Most of the uranium miners had also worked intermittently as shepherds and farm laborers.

The mean value of cumulative radon daughter exposure for the miners was 1,139.5 WLM, ranging from 58.8 to 2,125 WLM. The values for WLM were partly based on estimates. The mean length of time of exposure in the mines was 11.9 years, ranging

Table 1—*Data on Navajo Uranium Miners with Cancer of the Lung*

Case No.	Age at Death, yr	Date of Death	Time in Mines, yr	Working Level Months	Induction-Latent Period, yr
1	43	06-15-72	16	1,424.5	16
2	39	05-21-72	13	955	19
3	70	04-14-72	10	1,984.9	14
4	61	03-04-72	8	1,207.3	08
5	33	10-12-71	14	1,450	16
6	31	02-12-71	5	103	05
7	45	01-11-71	20	988.3	20
8	43	01-19-70	20	1,215.4	20
9	55	03-14-65	8	1,157.4	12
10	56	02-22-65	10	1,260	12
11	48	01-25-67	8	767	08
12	40	01-21-73	20	1,280	20
13	53	03-30-72	1.2	58.8	17
14	40	01-09-78	6	1,143	13
15	NA*	NA*	23	1,113	30
16	34	07-30-68	9	2,125	11

*Still alive, aged 52 years.

from six months to 23 years. The mean induction-latent period was 15 years, ranging from five to 30 years. The predominant cancer type found in this group was the small cell undifferentiated category (2A and 2B under the WHO classification scheme). The small cell undifferentiated type constituted ten of the 16 cases (62.5 percent); one cell type was unknown. Three cases were of the epidermoid type (19 percent), and two were of other types.

The smoking histories showed that 14 miners were nonsmokers, and two were light to moderate cigarette smokers (quantity not specified). The mean age at death of the miners was 46.1 years, ranging from 31 to 70 years. Six miners (38 percent) were aged 40 years or younger at time of death. One miner with lung cancer is still alive at age 52.

Discussion

Prior to 1946, the Navajo population was chiefly engaged in agricultural and handicraft activities: farming, shepherding, working with silver, sand-painting, and weaving rugs. Significantly low Indian morbidity and mortality rates for lung cancer, compared with both whites and blacks, were reported during this period.[10-13] The scarcity of lung cancer was attributed to the salubrious climate absence of occupational and environmental carcinogens, and the infrequency of cigarette smoking.

Extensive uranium mining in the Four Corners area began about 1946, stimulated by the urgent demand for atomic weaponry. This led to large-scale employment of Navajo Indians to work in underground and milling operations. About 1968, uranium mining activities were curtailed because adequate stockpiles of uranium existed. Between the years 1946 and 1968, underground miners were exposed to high levels of radiation in the mine air.[14]

Radiation in a uranium mine results from the decay of uranium into radon gas whether the ore is mined or not. Radon gas diffuses through the atmosphere as radioactive radon daughters (polonium 218, lead 214, bismuth 214, polonium 214), which have a short half-life of about 30 minutes. The radon daughters become adsorbed to dust particles in the air, which are inhaled and deposited on the tracheobronchial epithelium. Radiation is emitted to the lung tissue from the radionuclides in the form of α-particles.

The onset of intensive uranium mining in 1946 introduced respiratory occupational hazards to the Navajos. Poorly ventilated mines, inadequate radiation detection, and deficient inspection allowed dangerously high levels of radiation in the mine air. The levels of radiation often exceeded established

Table 2—*Data on Navajo Uranium Miners with Cancer of the Lung*

Case No.	Method of Diagnosis	Cell Type	Survival Time	Smoking History
1	Pneumonectomy	Small cell	24 mo	No
2	Sputum cytology	None	14 mo	No
3	Lobectomy	Squamous cell	2 mo	No
4	Liver biopsy	Undifferentiated	9 mo	Light to moderate
5	Scalene node biopsy	Undifferentiated	10 mo	No
6	Thoracotomy	Squamous cell	8 mo	No
7	Pneumonectomy	Oat cell	13 mo	No
8	Thoracotomy	Undifferentiated	9 mo	No
9	Autopsy	Alveolar cell	1 day	No
10	Bronchoscopy	Undifferentiated	21 mo	No
11	Thoracotomy	Undifferentiated	5 mo	Light
12	Autopsy	Oat cell	17 mo	No
13	Thoracotomy	Adenocarcinoma	9 mo	No
14	Bronchoscopy	Squamous cell	24 mo	No
15	Thoracotomy	Small cell	Still alive	No
16	Mediastinotomy	Small cell	4 mo	No

standards in the early days of the uranium mining industry.[6]

The hazardous levels of radiation existed until American scientific studies, concurring with European data, reported the association of lung cancer with high radiation levels in uranium mines. Wagoner and his associates[15] in 1965 reported that the incidence of lung cancer increased from 3.1 per 10,000 miners per year to 116.1 per 10,000 miners per year over six exposure categories, ranging from fewer than 120 WLM to more than 3,720 WLM. Lundin and his group[5] described an excess of lung cancer in uranium miners within the range 120 to 359 WLM. The doubling dose for the induction of lung cancer among uranium miners has been estimated at 120 WLM or 240 rads (1 WLM is equivalent to between 1 and 5 rads).

In this study, the mean cumulative radiation exposure was 1,139.5 WLM. Previous reports[5-15] have shown a notable excess in incidence of lung cancer associated with high radiation levels at this range. The highest incidence of lung cancer is occurring now in those miners who were exposed to cumulative radiation levels of 1,000 WLM or more. In this series, 11 miners had total cumulative radiation exposures in excess of 1,000 WLM.

The mean length of time spent in the mines for this group was 11.0 years. Wagoner and his group[16] reported a tenfold increase in lung cancer among long-term uranium miners. Each of 13 miners in this study spent ten years or longer in the mines.

The induction-latent period in this study ranged from five to 30 years, with a mean of 15 years. Long induction-latent periods have previously been reported. Saccomanno and his group[17] reported an average induction-latent period of 15.9 years in their study of lung cancer among uranium miners. In our study, lung cancer did not appear sooner than five years from onset of exposure.

The predominant cancer appearing in this series was the small cell undifferentiated type, composing 62.5 percent. Small cell undifferentiated carcinomas occurred in excess in uranium miners,[17] which is in accord with our study.

Cigarette smoking has been accepted as a major etiologic factor in the causation of lung cancer.[18] Cigarette smoking also plays an important role in the excess of lung cancer among uranium miners.[6-8,9] However, in this study, of the 16 miners with lung cancer, 14 were nonsmokers; two miners were light to moderate smokers. Archer and his group[19] reported that lung cancer in cigarette-smoking uranium miners has a shorter induction-latent period than lung cancer in nonsmoking miners. We also observed a shorter induction-latent period in the two cigarette-smoking miners, of eight years each (mean induction-latent period for the group was 15 years). The foregoing data imply that the nonsmoking miners still have an increased risk of lung cancer, and their tumors take longer to develop.

A recent study has observed a high lung cancer risk among nonsmoking miners; that smoking seems to offer some protection against lung cancer.[8] The study suggests that there might be a decreased a-radiation dose to the epithelium in smokers because of a protective thick mucous sheath, since underground miners are prone to the development of bronchitis.

Information on smoking habits obtained from hospital records tends, at times, to be obscure. The smoking history data for this series appeared to be credible. Also, the Navajos are traditionally nonsmokers.

The early age at death in this group was noteworthy. The average age at death was 46.1 years. Six miners were aged 40 years or younger at death. One miner with lung cancer is still alive at age 52.

Conclusions

1. Features of the lung cancers observed among the 16 Navajo uranium miners are consistent with those observed by others among whites, which are largely attributed to radiation exposure.

2. The minimal use of cigarettes among this group of uranium miners is a strong argument that cigarette smoking is not a major factor in the lung cancers of uranium miners. Our data indicate that cigarettes act as a promoting agent, and that radiation is the major cancer initiating agent.

ACKNOWLEDGMENT: We are indebted to Dr. Gerald D. Buker for his helpful contribution.

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The New England
Journal of Medicine

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Volume 310 JUNE 7, 1984 Number 23

URANIUM MINING AND LUNG CANCER IN NAVAJO MEN

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Abstract We performed a population-based case–control study to examine the association between uranium mining and lung cancer in Navajo men, a predominantly nonsmoking population. The 32 cases included all those occurring among Navajo men between 1969 and 1982, as ascertained by the New Mexico Tumor Registry. For each case in a Navajo man, two controls with nonrespiratory cancer were selected. Of the 32 Navajo patients, 72 per cent had been employed as uranium miners, whereas no controls had documented experience in this industry. The lower 95 per cent confidence limit for the relative risk of lung cancer associated with uranium mining was 14.4. Information on cigarette smoking was available for 21 of the 23 affected uranium miners; eight were nonsmokers and median consumption by the remainder was one to three cigarettes daily. These results demonstrate that in a rural nonsmoking population most of the lung cancer may be attributable to one hazardous occupation. (N Engl J Med 1984; 310:1481-4.)

URANIUM miners work in an atmosphere that is contaminated by radon daughters, the short-lived decay products of radon gas. Investigations of uranium miners and other underground miners have established a causal association between inhalation of radon daughters and the occurrence of lung cancer.[1-3] However, only limited data have been available from nonsmoking miners.

In the United States, the uranium industry developed during the late 1940s in the Colorado Plateau region of Colorado, Utah, Arizona, and New Mexico, including portions of the Navajo Indian Reservation near Shiprock, New Mexico (Fig. 1).[4,5] Uranium production from this portion of the Navajo reservation reached a peak during the 1950s and declined through the mid-1960s. Navajo men who were employed as uranium miners worked primarily in this area, but some mined off the reservation as well. Little information has been published concerning working conditions in the mines on the Navajo reservation. Limited surveys by the Public Health Service and other agencies have documented exposures to radon gas and silica dust.[1,6,7] Anecdotal accounts describe dusty mines with little effective ventilation.[8-10]

Excess mortality from lung cancer has been demonstrated in Navajo men who mined uranium in this region. A follow-up study of 780 American Indian miners, primarily Navajos, showed 11 deaths from respiratory cancer through 1974, with only 2.6 expected.[11] Among 17 Navajo men with lung cancer who were admitted to the Shiprock Hospital between 1965 and 1979, 16 had mined uranium.[12]

Since 1969, the New Mexico Tumor Registry, a member of the National Cancer Institute's Surveillance, Epidemiology, and End Results Program, has ascertained all incident cancer cases in the Navajo population of New Mexico, Arizona, and Utah.[13] We have used this resource to describe further the importance of uranium mining as a cause of lung cancer in Navajo men, a largely nonsmoking group. To accomplish this goal, we have performed a population-based case–control study of all 32 cases of lung cancer diagnosed among Navajo men between 1969 and 1981.

METHODS

For this investigation, all cases of primary lung cancer (n = 33) (*International Classification of Diseases for Oncology*, code 162) in Navajo males included in the New Mexico Tumor Registry file on August 31, 1982, were selected. One subject with a histologically confirmed carcinoid tumor was excluded. Of the 32 remaining cases, 28 were histologically confirmed, two were diagnosed by x-ray film, and two were identified by review of death certificates. Twelve of these cases were included in the series of Gottlieb and Husen,[12] six in a report by Archer et al.,[11] and six in both.

For each case, two deceased Navajo male controls with cancer other than lung cancer were selected from the Registry files. Deceased controls were used because only two of the Navajo subjects with lung cancer remained alive at the time of this investigation and death certificates were one source for occupational histories. The controls were matched to the cases for age (± five years) and diagnosis date (± five years). The primary tumor sites for the 64 controls were digestive (n = 35), male genital (n = 5), kidney (n = 4), brain

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Supported in part under a contract (N01-CP-33344) with the Biometry Branch, National Cancer Institute. Dr. Samet is a recipient of a Research Career Development Award (5 K04 HL 00951) from the Division of Lung Diseases, National Heart, Lung, and Blood Institute.

EXHIBIT 4

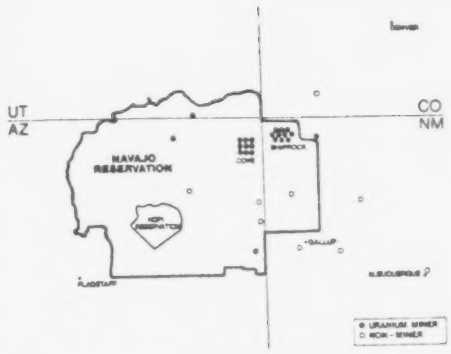

Figure 1. Residence at the Time of Diagnosis of Navajo Men with Lung Cancer.

(n = 3), lymphoma (n = 2), multiple myeloma (n = 3), leukemia (n = 4), and other, ill-defined and unknown sites (n = 8).

Sources of Data on Exposure

Multiple sources were used for all subjects to obtain information concerning occupation and smoking. For occupation, these included records maintained by the National Institute for Occupational Safety and Health (NIOSH), the Registry abstract of medical records, the occupation and industry stated on the death certificate, and listings of New Mexico uranium miners. Data from these sources were combined to determine whether each subject had ever been employed as a uranium miner. Each source is described separately below.

The major source of occupational data was the NIOSH rosters of uranium miners in the Colorado Plateau region, originally developed from annual censuses by the Public Health Service during the 1950s and 1960s and then maintained by NIOSH.[11] We were able to match 20 subjects, all cases, with this source on the basis of name and identical birth date or Social Security number (or both).

New Mexico Tumor Registry abstracts, completed for all cases and controls, sometimes mention occupation, although this item is not always available in charts and is not routinely collected. Relevant data from the abstracts were available for 21 cases and 26 controls. Death certificates could not be located for one case and five controls, and two cases remain alive. The 88 available death certificates provided information concerning occupation or industry for 21 cases and 32 controls.

Finally, we matched two cases with lists of New Mexico uranium miners that had been prepared for an ongoing mortality study.[14] The lists included most persons who had had a mining-related physical examination in the Grants, New Mexico, area between 1957 and 1976.

The cigarette-smoking history is not routinely collected by the New Mexico Tumor Registry but was obtained repeatedly in the Public Health Service longitudinal study. Smoking histories were unavailable for controls and were available for only 21 cases — from the Public Health Service data for 19 and from the New Mexico Tumor Registry for 2. For seven subjects who reported inconsistently over time, we selected the maximum amount smoked. Five of the seven stated on at least one questionnaire that they had never smoked cigarettes, and none reported a maximum greater than a few cigarettes daily.

The dates of exposure and the cumulative doses of radon daughter exposure were available from NIOSH records.[1] Exposure to radon daughters is measured in working-level months (WLM). The working level is any combination of radon daughters in 1 liter of air that ultimately releases 1.3×10^5 MeV of alpha energy during decay. Working-level months of exposure are calculated as the product of duration of exposure (measured as 170-hour working months) and the working-level values in the mines.

Statistical Analysis

The data were analyzed with standard techniques for a matched case–control study.[15] The statistical significance of the association between lung cancer and uranium mining was tested with an exact test developed by Gart.[16] A lower 95 per cent one-sided confidence level for the relative risk (rr) was calculated from the binomial distribution by setting $(rr \cdot rr + 2)^n = 0.05$, where n equals the number of exposure-discrepant triplets.[16]

For a further description of the effects of uranium mining in Navajo men, incidence rates were calculated with and without the cases in uranium miners. Mid-period (1975) denominators derived from Indian Health Service population estimates[17] were used. Rates were adjusted by the direct method to the age of the 1970 U.S. population for comparison.

Results

Of the 32 Navajo men with lung cancer in the period 1969-1981, 23 had been employed as uranium miners. This occupational history was documented for 20 by the NIOSH rosters and for the remaining 3 by New Mexico Tumor Registry abstracts. For 16 of the 20 included on the NIOSH lists, death certificates or New Mexico Tumor Registry abstracts were confirmatory.

A history of uranium mining could not be documented for any of the controls. One had worked in a lead, zinc, and silver mine. The association between uranium mining and lung cancer was statistically significant ($P = 1.1 \times 10^{-11}$). The estimate of relative risk was infinite because no controls were exposed. However, with use of the binominal distribution, the lower 95 per cent confidence limit for the relative risk was 14.4.

The age distribution of the affected Navajo uranium miners differed markedly from that of the affected Navajos who were not uranium miners and from that of men with lung cancer in the white U.S. population. The median age of the affected miners was 44 years, whereas that of the affected non-miners was 63 years — similar to that of affected men in the white U.S. population. The residences of the cases with a history of uranium mining were clustered in the northeast portion of the reservation around the Shiprock, New Mexico, and Cove, Arizona, area where the mines had been located (Fig. 1). In 1975, the Indian Health Service unit that included these communities comprised 24 per cent of the total Navajo population. In contrast, the residences of the nine affected non-miners were scattered across Arizona and New Mexico, as were the residences of the controls. During the 12-year study period, the number of lung cancer cases among uranium miners did not decline; 11 were diagnosed during 1969-1972, and 9 during 1978-1981. The median age for the earlier group of cases was 42 years, as compared with 54 years for the more recent ones.

For the 23 cases with uranium-mining experience, the median duration of employment in underground mines was 13 years. Six were employed there for less than 10 years. The median duration from the start of employment in uranium mining until diagnosis (in-

duction–latency period) was 23.5 years (range, 12 to 38), excluding one case for whom this period could not be determined.

Lifetime working-level months, calculated from job histories, were known for 14 cases and ranged from 30 to 2698, with a median of 1207. However, the two lowest values, 30 and 103 WLM, appear from our review of the records to be based on incomplete work histories. The third lowest value was 830.

Information concerning cigarette smoking was available for 21 of the 23 affected uranium miners (Table 1). Although the majority had smoked cigarettes, the amounts reported were low. Only five had smoked as much as four to eight cigarettes daily. No data on cigarette smoking were available for controls because the major source of these data was the Public Health Service records.

Table 1. Cigarette-Smoking Habits of 21 Male Navajo Uranium Miners with Lung Cancer.*

Cigarette Usage	No. of Men
Nonsmoker	8
Smoker	
<1 cigarette/day	2
1–3 cigarettes/day	6
4–8 cigarettes/day	5

*Data were not available for 2 of the 23 cases in uranium miners.

Discussion

American Indians have substantially lower rates of lung cancer than white and other nonwhite populations of the United States.[18-20] This pattern has been confirmed in the Navajo and other southwestern tribes by autopsy, mortality, and incidence data.[21-24] A low prevalence of cigarette smoking by American Indians, as suggested by the limited available data,[22,25] is the most obvious explanation for these differences. Of the American Indian miners in the Colorado Plateau investigation, 62 per cent had never smoked, and the median consumption by smokers was only four cigarettes per day.[11] Of a sample of adult Navajos admitted to the Phoenix Public Health Service Indian Hospital from 1961 through 1965, only 4.3 per cent smoked more than one pack of cigarettes daily.[26] In a 1977 survey of Navajos, only 13 per cent smoked and only 6 per cent of the smokers consumed at least one pack daily.[27]

The present investigation thus offers an assessment of the role of a single occupational risk factor, uranium mining, in a population at low risk for lung cancer. Case ascertainment through a population-based tumor registry for the Navajo tribe facilitated examination of the effects of this exposure in the entire tribe in this study, unlike previous studies.[11,12]

The association between uranium mining and lung cancer among the Navajos was strong, with a lower 95 per cent confidence limit of 14.4 for the relative risk. In fact, 72 per cent of the cases (23 of 32) are attributable to this industry. For all male Navajos, the average annual age-adjusted incidence rate of lung cancer for the period 1969-1981 was 16.6 per 100,000. Exclusion of the affected uranium miners lowered the rate to 5.2 per 100,000. This finding demonstrates that in a population at low risk for a specific cancer, exposure to a single risk factor may have readily detectable consequences and cause the majority of cases.

Bias cannot satisfactorily explain the results, although selection and information bias are possible. With regard to selection bias, the diagnosis of lung cancer may be more vigorously pursued in younger men with a history of uranium mining. However, in the younger age groups in which the proportion of cases attributable to uranium mining is highest, contact with medical care and intensity of evaluation were probably comparable for miners and non-miners. With regard to information bias, death certificates and the New Mexico Tumor Registry abstracts provided more complete occupational information for the cases. The Public Health Service censuses, however, were the major source used for identifying uranium miners. These censuses were prospectively collected and uniformly applied to cases and controls. Because of the size of the Public Health Service study group (n = 780), we expected to find that several controls had worked as uranium miners. The failure to identify any exposed controls may reflect better occupational information for cases or may have resulted from chance. Nevertheless, even if several controls had been uranium miners, the relative risk associated with this exposure would have remained high.

Differing smoking habits of cases and controls also cannot explain the effect of uranium mining. Because smoking histories were unavailable for controls, we could not directly assess the relative risk associated with cigarette smoking. In other populations, the relative risk for smokers of less than one pack per day ranges from approximately 2 to 10.[28] With a formula derived from a prospective study of British doctors,[29] we have calculated that the relative risk of lung cancer associated with smoking three cigarettes daily, the average consumption of affected Navajos who smoked, was only 2.3.

This investigation provides confirmation that uranium mining, without cigarette smoking, increases the risk of lung cancer in human beings. In animal models, inhalation of radon daughters alone causes respiratory neoplasms.[30,31] Supporting epidemiologic evidence has been available from few populations, including Colorado Plateau miners[1,11,12] and Swedish metal miners.[32,33] Smoking was probably not a prevalent risk factor among the early Schneeberg and Joachimsthal miners either, but documentation of their smoking habits is unavailable.[1,3]

Further follow-up will be needed for a complete characterization of the consequences of uranium mining in Navajos. The affected Navajos in this study were primarily younger men who began mining in the early 1950s. Exposure levels have declined since that

time,[14] and a federal standard of 4 WLM annually was implemented in 1971. More recent miners should have lower risks. However, the number of lung-cancer cases in Navajo uranium miners did not decline from 1969 through 1981, and more cases must be anticipated as these early miners age.

We are indebted to Clorinda Battaglia, of the National Institute for Occupational Safety and Health, for research support, and to Dr. John Gart, of the National Cancer Institute, for advice concerning calculation of the P values and confidence limits.

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Original Contributions

Lung Cancer Mortality Among Nonsmoking Uranium Miners Exposed to Radon Daughters

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Radon daughters, both in the workplace and in the household, are a continuing cause for concern because of the well-documented association between exposure to radon daughters and lung cancer. To estimate the risk of lung cancer mortality among nonsmokers exposed to varying levels of radon daughters, 516 white men who never smoked cigarettes, pipes, or cigars were selected from the US Public Health Service cohort of Colorado Plateau uranium miners and followed up from 1950 through 1984. Age-specific mortality rates for nonsmokers from a study of US veterans were used for comparison. Fourteen deaths from lung cancer were observed among the nonsmoking miners, while 1.1 deaths were expected, yielding a standardized mortality ratio of 12.7 with 95% confidence limits of 8.0 and 20.1. These results confirm that exposure to radon daughters in the absence of cigarette smoking is a potent carcinogen that should be strictly controlled.

(*JAMA*. 1989;262:629-633)

RADON daughters, both in the workplace and in the household, are a continuing cause for concern because of the well-documented association between exposure to radon daughters and lung cancer.[1-6] Few studies have, however, been able to assess the lung cancer risk from exposure to radon daughters in the absence of cigarette smoking. Studies among Navaho uranium miners, who were predominantly nonsmokers, have demonstrated rate ratios for lung cancer mortality of 4.2[2] and 14.4.[4] Studies of nonsmoking Swedish iron ore[3] and Czech clay shale[6] miners have both shown a rate ratio of 10.0 for mortality from lung cancer. These rate ratios for nonsmokers were generally higher than for cohorts of miners in which smokers and nonsmokers were combined.[3,6,7]

Various regression modeling techniques have been used to estimate the lung cancer mortality risks for nonsmokers from mixed cohorts of smokers and nonsmokers. Although these techniques are extremely powerful and useful, they require that certain assumptions be true, and the results are sometimes difficult to interpret. To provide additional information regarding the lung cancer mortality risks for nonsmokers exposed to radon daughters, we conducted a straightforward cohort mortality study of US, white, male uranium miners who never smoked cigarettes, pipes, or cigars.

From the Industrywide Studies Branch, Division of Surveillance, Hazard Evaluations and Field Studies, National Institute for Occupational Safety and Health, Cincinnati, Ohio (Mr Roscoe and Dr Steenland); the Epidemiology Branch, Division of Injury Epidemiology and Control, Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, Ga (Dr Waxweiler); Harvard School of Public Health, Boston, Mass (Dr Halperin); and the Division of Occupational and Environmental Medicine, University of California at Davis (Dr Beaumont).

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METHODS

Colorado Plateau Study Group

The cohort of white nonsmokers was selected from a larger cohort, also known as the Colorado Plateau study group and as the US Public Health Service (USPHS) uranium miners cohort, that consisted of 3359 white and 779 nonwhite men (total, 4138) who mined uranium on the Colorado Plateau.[1,4] These totals differ slightly from previous totals reported for this cohort because of racial reclassifications and duplications that have been corrected. To be included in the cohort, miners must have been examined in the USPHS medical surveys conducted between 1950 and 1960 and must have worked at least 1 month underground in a uranium mine by January 1, 1964. (Of the nonsmoking miners, all except 6 completed their first month of mining before the end of 1960.) Although lower before 1954, participation rates in the medical surveys reached approximately 90% of the miners in visited areas in 1957 and 1960.[1] Occupational, medical, and smoking histories were obtained during the examinations and updated during subsequent annual censuses of the miners conducted by the USPHS.

Selection and Verification of Nonsmokers Cohort

We selected for analysis only those white men who had never smoked cigarettes and were thus coded as "nonsmokers" according to their previously

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August 4, 1989, Volume 262
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EXHIBIT 5

of the four cells to be used in the analysis. The population proportions used in these calculations were taken from 1965 and 1980 National Center for Health Statistics survey data regarding smoking habits among white men in the United States.[9] The years 1965 and 1980 were chosen because they were approximately the midpoints of the two calendar periods—1950 through 1974 and 1975 through 1984. The smoking-specific relative risk estimates for lung cancer used in these calculations were taken from data regarding US veterans divided in the two age groups, 45 through 64 years and 65 years and older.[6] Since pipe and cigar smokers were included in the US proportions of non–cigarette smokers for 1965 and 1980, it was necessary for us to include pipe and cigar smokers in the veterans' risk estimates and in the cohort of non–cigarette-smoking uranium miners for the analysis based on US rates.

RESULTS

Accuracy in Smoking Codes

On review of the periodic questionnaires collected between 1950 and 1969 for the 681 white miners who had been previously computer coded as never having smoked cigarettes (nonsmokers), we found that some had actually smoked cigarettes (13%) and some had smoked pipes or cigars (11%). Those who ever smoked cigarettes were excluded from further analysis. Those who smoked only pipes or cigars were excluded from the analysis that used nonsmoking US veterans (no tobacco of any type) but were included in the second analysis that used estimated US nonsmoking rates. In total, 76% (516/681) reported never having smoked tobacco of any kind, and 87% (593/681) reported never having smoked cigarettes. We corrected all miscoding, including 3 persons with unknown smoking status.

Table 1.—Vital Status of White, Nonsmoking, Uranium Miners, With Follow-up Through 1984

Vital Status	No. (%) of Miners
Alive	387 (75)
Deceased	126 (24)
Certificate obtained	124 (98)
Certificate not obtained*	2 (0.02)
Unknown†	3 (0.01)
Total	516 (100)

*Includes one foreign death for whom no appropriate death certificate can be obtained.

†Persons with unknown vital status had their person-years at risk accumulated only until their last date observed.

Cohort Status

The 516 white nonsmokers had the following characteristics: mean year of birth, 1923; mean year first employed, 1952; mean age first employed, 29 years; mean time in underground uranium mining, 52 months; mean exposure to radon daughters, 720 WLM (median, 296 WLM); and mean rate of exposure to radon daughters, 16 WLM per month (median, 10 WLM/mo). The mean time since first employment in uranium mining until either death or the end of the study was 28 years; the mean time since last employment was 21 years. The mean age at the end of the study for the live cohort members was 56 years. Follow-up of the cohort through December 31, 1984, resulted in only 3 persons with unknown vital status and the identification of 126 deaths (Table 1). Fourteen deaths from lung cancer were found; characteristics of the 14 persons are reported in Table 2.

Lung Cancer: Veterans' Rates Comparison

When the number of observed deaths from lung cancer among the 516 nonsmoking uranium miners was compared with the expected number of deaths derived from the lung cancer mortality rates among white, male, nonsmoking US veterans, the SMR was 12.7 (95% CL, 8.0 and 20.1) (Table 3).

Lung Cancer: Axelson-Adjusted US Rates Comparison

The cohort of non–cigarette-smoking miners used in this secondary comparison consisted of the 516 nonsmokers plus 77 cigar and pipe smokers for a total of 593 nonsmokers. Cigar and pipe smokers were included because the data regarding the smoking habits of the US population included cigar and pipe smokers among nonsmokers of cigarettes. When the numbers of expected lung cancer deaths in the United States among white men were estimated for non–cigarette smokers by the Axelson method, we estimated the SMR to be 9.3 (95% CL, 5.6 and 14.5), based on 19 observed and 2.04 expected deaths.

Using the Axelson method, we estimated the following lung cancer rates for non–cigarette smokers in the United States: (1) 12% of the known overall US lung cancer rate for white men, aged 45 through 64 years, during the period 1950 through 1974; (2) 25% of the overall rate for ages 65 years and older, 1950 through 1974; (3) 12% for ages 45 through 64 years, 1975 through 1984; and (4) 24% for ages 65 years and older, 1975 through 1984.

Table 2.—Characteristics of White, Nonsmoking, Uranium Miners Who Died of Lung Cancer

Case No.	Year of Death	Age at Death, y	Years Since First Exposure*	Year First Employed	Age First Employed, y	Duration Employed, y	Years Since Last Exposure†	Uranium Exposure, WLM‡	Other§ Exposure, WLM‡	Total Exposure, WLM‡	Months Under-ground	Rate of Exposure, WLM/mo‡
1	1965	57.1	15.3	1948	41.8	12.8	2.7	403	82	485	41	10
2	1972	73.2	21.8	1950	51.8	9.5	12.1	16 487	0	16 487	90	183
3	1972	42.1	17.5	1955	24.8	13.0	4.5	520	0	520	134	4
4	1973	67.9	13.9	1959	53.9	8.1	5.8	709	74	783	98	7
5	1975	53.0	20.5	1954	32.8	10.2	10.3	555	7	562	116	5
6	1975	62.3	18.5	1956	45.7	8.9	7.8	2854	54	2908	62	46
7	1976	54.8	36.2	1940	18.6	28.6	7.8	2889	0	2889	214	14
8	1980	45.7	27.2	1953	18.5	15.9	11.3	2225	0	2225	124	18
9	1980	67.4	29.4	1950	37.9	13.6	15.9	4785	0	4785	157	30
10	1981	59.3	43.3	1938	15.9	30.8	12.5	4483	0	4483	347	13
11	1982	69.4	27.3	1955	42.1	9.1	18.2	952	0	952	101	9
12	1984	45.1	26.8	1957	18.3	10.9	15.9	1268	0	1268	93	14
13	1984	56.2	34.1	1950	22.1	17.0	17.1	1845	0	1845	162	11
14	1984	83.7	34.3	1950	49.5	15.6	18.7	1810	0	1810	163	11
Mean	1977	59.8	26.0	1951	33.8	14.6	11.4	2982	14	2998	138	27

*Time from first uranium mining until death; does not include other hard rock–mining employment.

†Time from last known uranium mining until death.

‡WLM indicates working level months.

§Other exposure to radon daughters from hard rock mining before uranium mining.

miners coded as smokers or ex-smokers, it seems more likely that smokers would have been incorrectly coded as nonsmokers than the other way around.

Errors in the classification of exposure to radon daughters might also have occurred. The coefficient of variation for the radiation exposure for the entire cohort of white, US, uranium miners was previously estimated to be 97%.[7] This implies that many miners might be classified in the wrong exposure categories. This misclassification, however, is independent of the exposure-disease relationship because the exposures were determined without knowledge of the disease outcome. Random misclassification has been shown to bias the mortality ratio toward 1.00, causing an underestimation of risk.[8]

Miners are exposed to radon daughters, not only from uranium mining, but from other underground, hard-rock mining as well. One hundred forty-two of the miners (28%) in our cohort had exposure to radon daughters from previous hard-rock mining. Their mean exposure from previous hard-rock mining was 46 WLM (median, 21 WLM). Although we did not consider these prior exposures in our analysis (Table 3), they were relatively small and would not have caused any of the deaths from lung cancer to enter different categories of exposure to radon daughters.

Besides radon daughters, the miners in our cohort might also have been exposed to diesel exhaust, silica, arsenic, nickel, cobalt, γ-radiation, and other substances associated with mining. Although these exposures were not considered in our analysis, they might have acted synergistically with radon daughters to potentiate the effects of exposure to radon daughters.

In our SMR analyses, we observed no deaths and thus estimated a relative risk of 0.0 for lung cancer among nonsmokers who fell in the exposure category of less than 360 WLM (Table 3). However, our power to detect any excess risk at lower exposure levels was low. For example, to have attained statistical power of 0.80 in the exposure category of less than 360 WLM and greater than 20 years since first exposure, an SMR of 10.37 would have had to exist with 0.3 expected deaths from lung cancer.[10] The power to detect a risk of 2.00 was 0.12.

An important consideration in using both the US veterans comparison population and the smoking-adjusted US comparison population, which we used for corroboration, was our selection of rates[11,12] and risk estimates[9] from the study of US veterans. The authors of that study noted that the veterans were mostly from World War I and were drawn mainly from the middle and upper socioeconomic classes and hence might not be very similar to Colorado Plateau uranium miners. However, our results would have been largely unchanged had we used the rates calculated by Hammond and Seidman[13] for American Cancer Society volunteers, the only other principal US cohort of smokers and nonsmokers studied prospectively (1960 to 1972). The veterans' rates seemed more appropriate because they covered the entire study period for the uranium miners—1950 through 1984.

In conclusion, we have demonstrated a 12-fold mortality risk for lung cancer for nonsmoking uranium miners exposed to radon daughters at a median level of 296 WLM (mean, 720 WLM) when compared with nonsmoking nonminers. No deaths from lung cancer were observed among nonsmoking miners who had accumulated less than 465 WLM of exposure to radon daughters; however, our statistical power to detect risks at lower exposures relevant to current occupational and most household exposures was not adequate in this analysis. These results confirm that exposure to radon daughters in the absence of cigarette smoking is a potent carcinogen that should be strictly controlled.

We would like to acknowledge the dedicated follow-up efforts of Clonnda Battaglia, Edith Dodd, Betty Walpole, Mary Hogan, Judy Edelbrock, Pauline Bischak, Isabel Nelson, Laurel Miller, and their staffs. We also wish to acknowledge the originators of the Colorado Plateau Uranium Miners Study, including Victor Archer, MD, Frank Lundin, Jr, MD, DrPH, Joseph Wagoner, SDHyg, and the staff of the erstwhile Utah Office of the US Public Health Service.

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Printed and Published in the United States of America

EXHIBIT 6

PART VI: RADIATION AND PARTICULATE MATTER

ANNALS OF N.Y. ACAD. OF SCIENCES 1976 #271

RESPIRATORY DISEASE MORTALITY AMONG URANIUM MINERS

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INTRODUCTION

Uranium, as found in nature, is normally at or near equilibrium with its decay products, which include the inert gas radon. Because radon diffuses from the rock into open areas of mines, most underground miners are exposed to radon concentrations in excess of those found above ground. The range of atmospheric radon concentrations in mines varies widely from 1×10^{-3} picocuries per ml (pCi/ml) of air in potash mines to 30 pCi/ml in some poorly ventilated mines.

When pure radon is breathed, it diffuses throughout the body and gives what is essentially whole-body radiation. Its retention, however, is limited, since most inhaled radon is also exhaled within its half-life of 3.8 days. For the immediate daughters of radon, however, the story is different. These radionuclides (^{218}Po, ^{214}Bi, ^{214}Pb, ^{214}Po) collectively have an average half-life of about 30 minutes. When formed in the air of a mine, they quickly become attached to solid surfaces, most notably dust particles. When these dust particles with attached radionuclides are inhaled, the radiation from them (largely alpha particles) is delivered to those sites in the nose, pharynx, and tracheobronchial tree where the dust particles are deposited. The radiation dose delivered to the lungs of uranium miners by these elements is about 20 times greater than that from inhaled radon. Measurements of radiation exposure and of the biologic effects of this exposure on miners have been attempted repeatedly since about the year 1880.

Previous studies of United States uranium miners have shown that their risk of respiratory cancer is related to the magnitude of exposure to radon daughters.[1-3] A similar excess, however, was not clearly demonstrated among either non-cigaret-smoking white uranium miners or among non-white uranium miners (mostly American Indians).[1] Some publications reported a loss of pulmonary function among uranium miners,[4] but little attention was paid to their mortality from pulmonary insufficiency. An update of the earlier mortality studies now has been made that provides data for filling in these three deficiencies.

MATERIALS AND METHODS

An intensive follow-up was done on the 3,366 white and 780 non-white workers who had been examined by our traveling medical teams between 1950 and 1960 and who had one or more months of underground uranium employment prior to January 1, 1964. Detailed occupational and smoking histories had been obtained by personal interview at the time of examination, in many cases

repeatedly. These data were supplemented by an annual census of uranium miners from 1954 through 1969 and by main questionnaires.

The follow-up cut-off date was January 1, 1974, for Indians, and September 30, 1974, for whites. The followup was accomplished with the help of the Internal Revenue Service, credit agencies, state motor vehicle registrations, and telephone calls to relatives and trading posts (Indians), and by searching death certificate files in three states.

Death certificates were obtained for the known dead, and cause of death was interpreted according to the Revision of the International Lists of Diseases and Causes of Death in effect at the time of death by a qualified nosologist. Those individuals whose vital status was not ascertained were considered alive, thus making conservative any finding of increased cause-specific mortality among the study group. In addition, those individuals who had been reported dead but for whom no death certificates were obtained were considered as deceased on September 30, 1974, cause of death undetermined.

Cumulative radon-daughter exposure values were calculated for each miner from the date of his first mining to each sequential month of observation through September, 1969. These values were expressed as Working Level Months, that is, the cumulative product of length of underground exposure in working months (170 hours) and the concentration of radon daughters in "Working Levels" (WL) specific for mine and calendar year. One Working Level is equal to 1.3×10^5 MeV of potential alpha energy per liter of air. It was impractical to carry these calculations beyond 1969. Furthermore, little additional exposure was received by most of the workers after this date. Radiation levels in uranium mines dropped sharply after 1967, and relatively few of the study-group members continued mining uranium after 1967. With a dropout rate of 10–50%/year after 1960, it was determined in 1965 that only 12.3% of the study-group members were still mining uranium. The dropout has continued to date, but we have not determined the number still mining in 1974. It must be small.

A modified life-table technique was used to obtain person-months at risk of dying between August, 1960 and January 1, 1974 for Indians and between July, 1950 and September 30, 1974 for whites. The person-months were obtained for each calendar year for each five-year age group, for each time interval after the start of underground uranium mining, and by estimated cumulative radon-daughter exposure with estimated WLM from both uranium mines and other metal mines for whites, but just uranium mines for Indians, since few of them had ever worked in nonuranium mines.

Comparisons with the male non-white population of Arizona and New Mexico were made for Indians, and the male white population of the United States was used for white miners. Excesses and deficits were identified by noting the observed number of deaths among miners in relation to the expected number. This expected number was calculated by applying male rates specific for age, race, calendar year, and cause of death to the appropriate number of person-years at risk. No further analysis was done with the Indian mortality, since there were few respiratory cancers.

An exposure-response analysis by cigaret-smoking groups was done for both respiratory cancer and for all respiratory disease deaths other than tuberculosis and cancer among white miners. These diseases were largely pulmonary insufficiency and were recorded as pneumoconiosis, pulmonary fibrosis, emphysema, and others, but there were also a few pneumonias, asthmas, and so on.

The chest films made between 1950 and 1960 and the readings of the made by a panel of radiologists were available. The 98 persons found to ha pneumoconiosis when examined were matched against the men who had di of respiratory cancer or "other respiratory disease," or who had some type c chronic obstructive pulmonary disease mentioned on their death certificates a "other significant condition," in an attempt to learn what contribution x-r pneumoconiosis made to the later respiratory disease deaths.

Results

Follow-up was 100% among the Indians, with death certificates obtained o all deceased members. Only 60 white (1.8%) were lost to follow-up, and deat certificates were obtained on all of the known dead. The seven unknown cause of death among Indians and the nine among whites had such notes as "natura causes" and "dead on arrival," with no further notations on the death certificate

Table 1 shows that 107 deaths occurred among Indians during the follow-up periods. Among Indians, the overall expected and observed rates were about the same, but there were marked differences in distribution. Respiratory cancer was the only death cause which was significantly higher than expected. Three additional deaths were probably due to lung cancer, but were not studied sufficiently to establish the diagnosis. There was a trend toward excess death

Table 1

Observed and Expected Deaths by Cause among American Indian Underground Uranium Miners: January 1960–January 1, 1974

Cause of Death	List Number	Observed	Expected
Tuberculosis, all forms	001–019	8	3.7
All malignant neoplasms	140–205	17 †	9.9
Digestive system *	150–159	6	3.8
Respiratory	160–164	11 ‡	2.6
All other malignant disease		2	3.5
Vascular disease of central nervous system	330–334	1 †	6.2
All heart diseases	401–443	2 ‡	19.2
All respiratory disease (nonmalignant)	470–527	7	5.4
Cirrhosis of liver	581	1 †	6.8
All accidental deaths	800–962	39	31.7
Motor vehicle	810–825, 830–835	21	16.2
All other accidental deaths		18	15.5
Suicide and homicide	963, 964, 970–979, 980–985	5	9.7
All other known causes		20 †	31.3
Unknown causes		7	0.0
TOTAL		107	123.9

* Indented causes of death are not added into totals.

† Significant at $<5\%$.

‡ Significant at $<1\%$.

TABLE 2

CIGARET-SMOKING HABITS OF THE AMERICAN INDIAN MINERS

Packs per day	Smoking at Time of Examination	Amount Smoked by Former Smokers	Unknown	Never Smoked
0.0	—	—		487
0.1	117	18		
0.2	50	3		
0.3	23	2		
0.4	3	3		
0.5	37	5		
0.6	1			
0.7	2			
0.8	1			
0.9	1			
1.0	20			
1.5	1			
2.0		1		
Unknown			4	
TOTALS	256	32	4	487

for tuberculosis, other nonmalignant respiratory disease, and accidental deaths. There were significantly fewer deaths from heart diseases, from vascular disease of the central nervous system, and from liver cirrhosis than had been expected. Even if all the unknown causes of death were sudden death from heart attacks or strokes, there would still be a deficit of these deaths.

The distribution of cigaret smoking among the Indians is given in TABLE 2, indicating that as a group they used little tobacco.

The 745 deaths among white miners (TABLE 3) are substantially greater than the expected number. Substantial excess deaths occur in three categories: respiratory cancer, nonmalignant respiratory disease, and accidents. Accidents while at work (most of the "other accidents") account for most of the excess deaths from this cause. There was a tendency toward elevated deaths from "all other malignant disease," and from motor vehicle accidents. The excess of both auto and other accidental deaths is greatest among inexperienced workers (less than 10 years on the job) and falls essentially to expected levels at 25 years after start of mining. Respiratory disease (both malignant and nonmalignant) is not elevated among workers with less than five years experience, begins to rise during the five- to ten-year period and rises rapidly with longer time intervals after the start of mining. There is a tendency to a deficit of deaths due to liver cirrhosis and to heart and other vascular diseases.

The exposure-response curves for both bronchogenic cancer and for pulmonary insufficiency show a clear relationship to cumulative exposure as expressed in Working Level Months (WLM) (TABLES 4 and 5, FIGURES 1 & 2). The separation into cigaret-smoking groups clearly indicates that cigaret smoking has played a part in both cancer and pulmonary insufficiency deaths, but that both occur in the absence of cigaret smoke. The linearity of several of the curves, especially for nonsmokers, is remarkable.

TABLE 3

OBSERVED AND EXPECTED DEATHS BY CAUSE AND BY TIME AFTER START OF URANIUM MINING AMONG WHITE UNDERGROUND MINERS: JULY 1950–SEPTEMBER 1974

Cause of Death List	Years after Start of Underground Uranium Mining									
	0–4.9		5–9.9		10–24.9		25 and over		Totals *	
	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Tuberculosis 001–019	0	0.6	1	0.8	4	2.0	0	0.5	5	3.9
All malignant 140–205 neoplasms	6	6.9	22	15.1	142 †	56.2	36 †	15.8	206 †	93.9
Brain and nervous system 193 ‡	0	0.4	0	0.7	3	2.0	0	0.4	3	3.5
Digestive system 150–159	2	2.0	5	4.3	13	15.8	5	4.8	25	26.9
Respiratory system 160–164	2	1.9	12 †	4.6	103 †	18.3	27 †	4.9	144 †	29.8
Lymphatic & hematopoietic system 200–205	1	1.0	2	1.9	4	5.9	1	1.4	8	10.2
All other malignant diseases	1	1.6	3	3.6	19	14.1	3	4.2	26	23.5
Vascular disease of central nervous system 300–334	0	2.0	2	4.5	15	18.7	2	7.0	19 §	32.3
All heart disease 401–443	0 §	15.6	27	34.1	102	129.4	28	39.0	166 §	218.2
All respiratory disease (nonmalignant) 470–527	1	1.5	7	3.5	54 †	15.0	18 †	4.8	80 †	24.9
Cirrhosis of liver 581	0	1.2	0	2.6	7	8.7	0	1.8	7	14.2
All accidental deaths 800–962	42 †	7.2	41 †	10.1	51 †	22.5	6	3.6	140 †	43.3
Motor Veh. 810–825, 830–835	12	4.0	9	5.3	15	10.8	2	1.5	38 †	21.5
All other accidental deaths	30 †	3.2	32 †	4.8	36 †	11.7	4	2.1	102 †	21.8
Suicide and homicide 963, 964, 970, 979, 980–985	7 §	2.3	2	4.0	13	9.8	0	1.5	22	17.7
All other known causes	16 †	5.7	23 †	10.8	43	37.1	9	10.6	91	64.2
Unknown causes	1	0	0	0	7	0	1	0	9	0
Totals *	73	43.1	125	85.4	438 §	299.3	100	84.7	745 §	512.5

* Marginal totals may not check exactly because of rounding.
† Difference is significant at 1% level.
‡ Indented causes of death are not used in obtaining totals.
§ Difference is significant at 5% level.

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TABLE 4

RESPIRATORY CANCER MORTALITY AMONG WHITE MINERS BY WLM AND BY CIGARET SMOKING, FIVE OR MORE YEARS AFTER START OF MINING: JULY 1950–SEPTEMBER 1974

Smoking Group	Working-Level Months								
	1–359			360–1799			1800 and above		
	Cancers	Person-Years	Cases per 1,000	Cancers	Person-Years	Cases per 1,000	Cancers	Person-Years	Cases per 1,000
Nonsmokers	1	4917.73	0.20	3	3487.94	0.86	2	1436.54	1.39
1–19 Cigarets/day	5	3169.42	1.58	3	2617.77	1.14	6	716.78	8.3
20 Cigarets/day	9	6907.38	1.30	29	8236.88	3.52	30	3175.58	9.4
Over 20 Cigarets/day	8	2944.12	2.72	17	3634.63	4.68	15	1126.53	13.3
Former Smokers	3	1009.6	2.97	6	1842.18	3.26	9	888.03	10.13

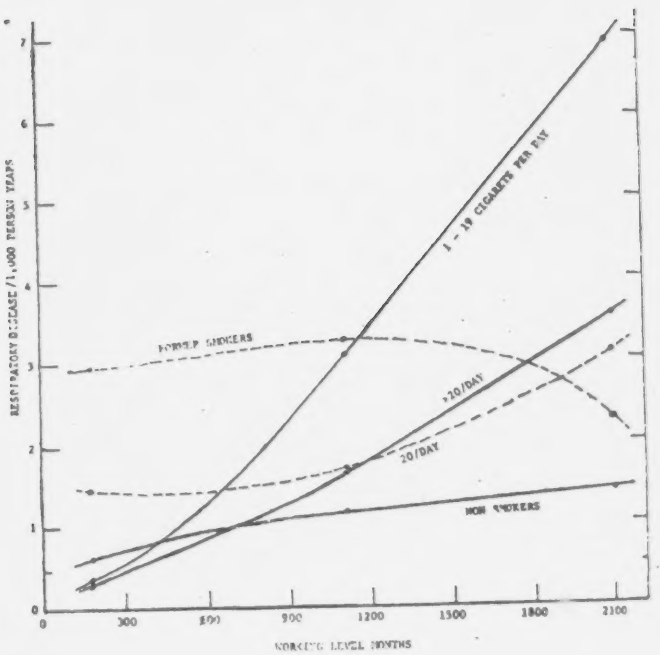

FIGURE 2. Respiratory disease mortality (other than cancer and TB) as relate to radon daughters, by cigaret-smoking groups.

TABLE 6

OTHER ACCIDENTAL DEATHS AMONG WHITE UNDERGROUND URANIUM MINERS BY LENGTH OF MINING EXPERIENCE

Years After Start of Underground Mining	Observed	Expected	Ratio of Obs./Exp.
0–4.9	30	3.199	9.4
5–9.9	32	4.812	6.6
10–14.9	17	5.466	3.1
15–24.9	19	6.246	3.0
25 or more	4	2.078	1.9

Discussion

The excess respiratory cancer among Indians not only shows that Indians are not immune to radiation-induced cancer, but also indicates that radio-induced bronchogenic cancer occurs when cigaret usage in the exposed group is minimal or absent (Tables 7, 8). Of the 14 respiratory cancers among Indians (including one not definitely diagnosed), four stated, at time of examination, that they

Table 7

Data on Indians and White Non-Cigaret Smokers Whose Death was Certified as Due to Respiratory Cancer

Case No.	Age at Death	Usual Cigarette Usage	Years of Smoking	Induction-Latent Period	Histologic Type of Tumor WHO Classification *	WLM of Radon-Daughter Exposure	Race
[illegible]	42	0	0	17	2B	867	Indian
[illegible]	60	3–6/day	50?	24	1A	2760	Indian
[illegible]	55	2–3/week	30?	14	2A	1325	Indian
[illegible]	40	3–4/day	~3	20	2A	2039	Indian
[illegible]	44	2–3/day	15	19	2A	782	Indian
[illegible]	35	3–6/day	~15	17	2B	3234	Indian
[illegible]	43	0	0	21	not available	3202	Indian
[illegible]	39 †	0	0	21	not available	3052	Indian
[illegible]	45	10–20/day	29	15	2B	2038	Indian
[illegible]	56	2–3/week	20	15	2B	1415	Indian
[illegible]	60	0	0	23	2B	1336	Indian
[illegible]	73	0	0	23	3A	16467	white
[illegible]	65	0	28 ‡	13	1A	2573	white
[illegible]	56	0	0	15	2A	465	white
[illegible]	67	0	0	14	2B	783	white
[illegible]	42	0	0	18	2A	520	white
[illegible]	62	0	0	17	2A	2908	white

* In the WHO Classification, 1A=well differentiated epidermoid; 2A=oat cell; 2B=small round or polygonal cell; and 3A=well-differentiated adenocarcinoma.
† Clinical data not clear as to origin; may have originated in colon.
‡ He smoked 6–10 cigars daily for 28 years.

never smoked, two smoked two to three cigarets/week, six smoked two to six cigarets/day, one smoked one to ten/day, and one smoked ten to twenty/day. The time from start of mining to cancer (induction-latent period) for these fourteen men range from 11 to 24 years, with a mean of 17.1 years. The mean induction-latent period for the four nonsmokers was 20.5 years. These mean times may be contrasted with a mean of 13.7 years induction-latent period among 15 white uranium miners with lung cancer who smoked 20 cigarets or

more per day and died before 1963, when an excess was first clearly demonstrated among them. This shortened induction-latent period for heavy smoke has been previously demonstrated.[6]

The expected lung cancer rates calculated on the basis of non-white rates for Arizona and New Mexico is as close as we could get to appropriate rates since there are substantial Indian populations in both states. There are, however, substantial numbers of blacks and orientals in both states who are included in the non-white mortality rates. The ratio of Indians to other non-whites is greater for these two states than for Utah or Colorado, where some of the Indian miners worked. Most of the Indian miners were Navajos from Arizona and New Mexico, although a few were born in Utah and Colorado. Male Indians (nonminers) have a total cancer and respiratory cancer rate that is

TABLE 8

RELATIONSHIP OF EARLY X-RAY PNEUMOCONIOSIS AMONG WHITE MINERS TO SUBSEQUENT BRONCHOGENIC CANCER AND CHRONIC OBSTRUCTIVE PULMONARY DISEASE

	No.	Men who Later Developed Bronchogenic Cancer	Men who Died of Pulmonary Insufficiency	Men who Had Chronic Obstructive Pulmonary Disease Noted on Death Certificate as "Other Significant Condition"	Ratio of Cancer:Insufficiency:D.C. Note
X-ray pneumoconiosis 1950–1960					
Number	98	17	15	10	1:0.88:0.59
Percentage	—	17.3	15.3	10.2	
No x-ray pneumoconiosis 1950–1960					
Number	3268	126	120	65	1:0.95:0.52
Percentage	—	3.8	3.7	2.0	

approximately half that of United States rates for white or non-white.[7,8] For this reason, the "expected" respiratory cancer rates in TABLE 1 are undoubtedly overestimated. It should also be noted that most Indian uranium mine respiratory cancers are of the small-cell undifferentiated variety (8 out of 9 with good histology were small-cell undifferentiated), similar to the predominant type among white uranium miners.[9] The radiation exposure among the 14 Indians ranged from 782 to 3234 WLM with a mean of 2004 WLM, which indicates that most of the cancers have come from the more heavily exposed groups, consistent with the findings among white miners.

The deficit of vascular diseases of the heart, kidneys, and central nervous system among Indians is thought to be due to a combination of medical selection of miners through preemployment examinations, to minimal tobacco use, to

their diet, which is generally low in saturated fats, to a way of life involving considerable exercise, and possibly to a racial factor. Low death rates from cirrhosis of the liver among most employed groups probably reflects lower use of alcohol by working groups than by the general non-white population. Miners who abuse alcohol do not usually hold jobs very long.

The mortality pattern of white miners (TABLE 3, FIGURE 1) has changed somewhat from earlier reports. The excess of "other respiratory" and the deficit of cardiovascular disease deaths is a definite shift. The two may be related; i.e., men dying of pulmonary insufficiency might have died a few months or years later of heart disease. The death certificate coding appears to underestimate the magnitude of the shift, inasmuch as many of those heart disease deaths carry such notes as "right heart failure," "cardiorespiratory failure," emphysema, pulmonary fibrosis, and so on, often as an "other significant" entry.

The linear curves for nonsmokers in both FIGURES 1 and 2 argue for a direct dose-response in both respiratory cancer and "other respiratory disease" deaths. Some of the curves from cigaret groups are nearly linear also, but others are markedly curvilinear. The heaviest smokers have the highest incidence of respiratory cancer, as expected, but the differences between them and a pack a day or former smokers is not large.

The curves for light smokers are anomalous. At high radiation levels their cancer risk is nearly as great as among heavier smokers, but is much less at lower radiation levels. With respect to deaths from "other respiratory disease," the light smokers appear to have all the worst of it, and exhibit a more linear exposure-response curve than heavier smokers. This pattern suggests that heavy smoking may give protection against the development of parenchymal injury—possibly by the production of extra mucus, which shields cells from the minimally penetrating alpha radiation of radon daughters—but that light smoking does not give this protection. This apparent protection does not extend to cancer induction, however, which probably arises in the walls of larger bronchi.

No specific condition can be pinpointed as the cause of the excess "other respiratory disease" deaths. It appears to be pulmonary insufficiency resulting from diffuse radiation injury to lung parenchyma, leading to later fibrosis and emphysema. Cigaret smoke clearly contributes to it. Siliceous dust and diesel exhaust in mines would be expected to contribute an additional increment of damage.

The ratio of "other accidental deaths" (mostly due to mine accidents, TABLE 7) to expected, drops with time after start of mining. This undoubtedly represents a learning response, since beginners are at highest risk. This drop with time is in strong contrast to respiratory cancer and "other respiratory" deaths that rise with time. This latter pattern is typical of chronic occupational diseases: low initially, but constantly rising with increasing time after start of exposure.

The ratios of x-ray pneumoconiosis:lung cancer:pulmonary insufficiency deaths:chronic obstructive lung disease noted as "other significant condition" were surprising (TABLE 8). We had supposed that persons with x-ray pneumoconiosis would be much more likely to die of pulmonary insufficiency than other men. However, the ratios suggest that the earlier x-ray pneumoconiosis had little or no relevance to subsequent respiratory disease deaths, and that both types of disease (cancer and insufficiency) were primarily related to radiation exposure or cigaret smoking rather than to siliceous dust. This is consistent

with the data in TABLE 4 and FIGURE 2. An alternative hypothesis, not ruled out by present data, is that early x-ray pneumoconiosis increases lung susceptibility to both cancer and pulmonary insufficiency equally.

Data in FIGURE 1 and TABLE 7 clearly indicate that underground uranium-miners who do not smoke cigarets or who smoke just a little, suffer an increased risk of lung cancer (most bronchogenic cancers among nonsmoking, nonminers are adenocarcinomas), although their risk is substantially less than that of heavy smokers.

In an earlier report,[1] with use of a computer model, it was calculated that for 30 years' exposure at 4 WLM/year, a group of 20-year-olds, by age 80, would have about a 45% increase of respiratory cancer over expected numbers. Since the bulk of expected cancers is due to cigaret smoking, this means that the respiratory cancer risk from 30 years' exposure at 4 WLM/year is about half that of smoking cigarets at the rate our miners have used them in the past. However, because there was some overestimation of exposures in that analysis and because the median ten-year latent period now appears to be a little short, that earlier estimate of risk from 4 WLM/year is probably a little low.

SUMMARY

A mortality analysis of a group of white and Indian uranium miners was done by a life-table method. A significant excess of respiratory cancer among both whites and Indians was found. Nonmalignant respiratory disease deaths among the whites are approaching cancer in importance as a cause of death, probably as a result of diffuse parenchymal radiation damage. Exposure-response curves for nonsmokers are linear for both respiratory cancer and "other respiratory disease." Cigaret smoking elevates and distorts that curve. Light cigaret smokers appear to be most vulnerable to lung parenchymal damage. The predominant histologic cancer among nonsmokers is small-cell undifferentiated, just as it is among cigaret smokers.

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United States of America

Congressional Record

PROCEEDINGS AND DEBATES OF THE 96th CONGRESS, FIRST SESSION

Vol. 125 WASHINGTON, THURSDAY, SEPTEMBER 27, 1979 No. 127

S. 1827—URANIUM MINERS COMPENSATION ACT OF 1979

Mr. DOMENICI. Mr. President, we have all heard and read much in the media during the past several months about the health problems of our Nation's first uranium miners, those who mined during the 1950's and 1960's when the Atomic Energy Commission was the sole procurer of uranium for defense purposes.

Mr. President, on August 30, 1979, I chaired a hearing of the Senate Special Committee on Aging in Grants, New Mexico, the heart of uranium country, to learn firsthand about these problems as they have come to affect my own constituents.

Many of the miners of the 1950's and 1960's are constituents of mine in New Mexico.

During the hearing, I received testimony from afflicted uranium miners from grants and from the Navajo Nation, their families, local government officials, health experts, workmen's compensation attorneys, mine safety and health experts, and representatives from the mining companies and the unions.

Unfortunately, much of what we have read about this subject in the press is true. Significant numbers of urmanium miners who extracted uranium from the Colorado Plateau, and from other early uranium producing States, are paying the price today for the inadequate safety and health standards that were then in force. I asked the afflicted miners to contrast for me the situation in the early mines with existing conditions. Almost to a man they responded that there was no comparison, from a health and safety standpoint, between the deplorable conditions in the early uranium mines and the markedly improved situation in the uranium mines of today.

The price these men paid, and are still paying, was and is a high one. Excessive numbers of them have contracted various types of cancer and respiratory impairments as the direct result of their employment in poorly ventilated mines.

Furthermore, it was uncovered at the grants hearing that many of our early miners have "fallen through the cracks" of existing State workmen's compensation systems, and that they and their families are not being adequately compensated for their mine-related illnesses, and in many instances they are not being provided with adequate health care.

Mr. President, we all know that workmen's compensation is the institutional means of protecting workers from industrial accidents. But when it comes to these early miners in the four corners States of the Colorado Plateau it is obvious to me that many "fell through the cracks" and are not receiving compensation for various technical reasons.

It is my opinion that we, the Federal Government, owe our Nation's first uranium miners and their survivors more than just a moral debt. We owe them decent medical care and a measure of financial security. The legislation I am introducing today will set up a totally federally-financed mechanism for providing compensation to uranium miners who are disabled by cancer and respiratory diseases resultign from overexposure to radiation and dust during the early days of uranium mining. Compensation will also be provided to the survivors of our early afflicted miners.

The bill will be administered by the Department of Health, Education, and Welfare, specifically the Social Security Administration, with the Secretary prescribing regulations for determining whether a miner is totally disabled due to a radiation or dust-induced disease and whether the disease was related to uranium mine employment.

Under my legislation, which is a revised version of a bill I introduced during the last Congress, S. 3199, an afflicted uranium miner who worked for 3 years or more in one or more uranium mines prior to the implementation of Federal standards in mid-1971 is potentially eligible for benefits. Compensable diseases include lung cancer, bronchial cancer, lymphatic cancer, pulmonary fibrosis, silicosis, and any other disease which the Secretary concludes is radiation or dust-induced and which resulted from uranium mine employment. Underground miners, surface miners, millers, and any other individual who work in or on the premises of a uranium mine or uranium milling facility in the extraction or preparation of uranium are potentially eligible for benefits. Survivors

of miners who worked for 3 or more years prior to implementation of Federal standards are also potentially eligible for benefits under the act.

Benefits payable under the legislation will be set at the following levels:

Miner or widow, $304.74 per month; 1 dependent, $457.11 per month; 2 dependents, $533.30 per month; and 3 dependents, $609.48 per month.

This benefit schedule will be adjusted annually to reflect changes in the GS–2 wage base. Benefits received under the act are not subject to Federal income tax. Benefits will be offset by any moneys received through workmen's compensation, unemployment compensation, or disability insurance received as the result of a radiation or dust-induced disease.

Moneys received as the result of a tort claim, either against the Government or against a private employer, will also be offset against payments received under this legislation.

Any miner eligible for benefits under this act shall be furnished with necessary services, appliances, and supplies prescribed or recommended by a qualified physician if the Secretary concludes that they are likely to cure the miner or lessen the extent or degree of his disability. The miner may select his own physician, in accordance with the Secretary's regulations, and may be furnished necessary and reasonable expenses incident to securing such services, appliance and supplies. The bill also authorizes contracts and grants for the construction, purchase and operation of fixed-site and mobile clinical facilities for the analysis, examination and treatment of afflicted miners.

Furthermore, the measure sets up two notification programs. One of these systems is designed to warn early miners of the health hazards to which they were exposed during the 1950's and 1960's. The other program is designed to notify potential beneficiaries of their eligibility for benefits under this act. Such notification programs must be written or broadcast in simple and direct language and, where applicable, translated into the native language of the individuals to be notified.

The average uranium miner of today has a good income, works in a safe and healthful environment, has a nice home, good insurance, and benefits awaiting him should he need them. But the uranium miner of two decades ago never had those things. I believe that it is time to get the job done with respect to our early miners, get something passed, and take care of an era that we do not want to go back and relive. The legislation I am proposing today is designed to achieve that goal.

Mr. President, it is very difficult to draw up a bill which covers all circumstances. This measure is an improvement over the bill I introduced in the last Congress. I hope the appropriate committee will conduct hearings, and, if the bill is in need of further refinement, I stand ready to assist in any way I can.

I want to take this opportunity to acknowledge the fine work that Senators HATCH and KENNEDY have done in this area, and to thank them for their continuing interest in this area, and to thank them for their continuing interest in this issue. I look forward to working closely with them and the members of their staff on this issue in the coming months.

Mr. President, I ask unanimous consent that the text of my bill be printed in the RECORD, and that it be appropriately referred.

There being no objection, the bill was ordered to be printed in the RECORD, as follows:

S. 1827

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Uranium Miners Compensation Act of 1979".

FINDINGS

SEC. 2. (a) The Congress finds that—

(1) morbidity and mortality rates among uranium miners who worked in the Nation's uranium mines prior to the full implementation of the final regulations promulgated pursuant to the Federal Metal and Nonmetallic Mine Safety Act prior to its repeal under the Federal Mine Safety and Health Act of 1977 which were published in the Federal Register on December 8, 1970 are excessively high;

(2) promulgation of, enforcement of, and compliance with, health and safety standards prior to the full implementation of the final regulations promulgated pursuant to the Federal Metal and Nonmetallic Mine Safety Act prior to its repeal under the Federal Mine Safety and Health Act of 1977 were not adequate to prevent excessively high rates of subsequent mortality and morbidity;

(3) It is anticipated that this excess of disease and death among uranium miners who unknowingly were exposed to unusually high levels of radiation will increase with the passage of time due to the long latent period associated with the manifestation of such diseases and deaths;

(4) existing workmen's compensation laws in most States do not provide adequate benefits to afflicted uranium miners or to their survivors due to strict statutes of limitations and unrealistic burden of proof requirements which do not take into account the long latency period of radiation-induced diseases;

(5) although the primary diseases manifest by uranium miners are radiation-induced, uranium miners also manifest dust-induced diseases, appearing as pulmonary and respiratory impairments and terminating usually in pulmonary fibrosis, silicosis or corpulmonale;

(6) under existing workmen's compensation laws in most States, uranium miners and their survivors are often not provided compensation benefits for disability or death resulting from dust-induced latent diseases arising out of employment in the mines;

(7) it is the responsibility of the Federal

Government, the sole contractor of uranium for defense purposes until 1963, to establish a mechanism for providing adequate benefit levels to uranium miners and their survivors, and to assume full financial liability for all costs incurred under this mechanism;

(8) there are a significant number of uranium miners today who are totally disabled due to a radiation-induced or dust-induced latent disease rising out of employment in one or more of the Nation's uranium mines; and

(9) many uranium miners whose deaths were due to radiation-induced latent disease or who were totally disabled by radiation-induced or dust-induced latent disease at the time of their deaths are survived by dependents.

(b) It is the purpose of this Act to ensure that adequate benefits are provided by the Federal Government to those uranium miners whose disability resulted from radiation-induced or dust-induced latent disease contracted as the result of employment in mines prior to the full implementation of the final regulations promulgated pursuant to the Federal Metal and Nonmetallic Mine Safety Act prior to its repeal under the Federal Mine Safety and Health Act of 1977, and to the survivors of miners who had been afflicted, and died from, radiation-induced or dust-induced latent disease.

SEC. 3. For purposes of this Act—

(a) the term "dependent" means—

(1) a child as defined in subsection (h) of this section without regard to subparagraph (2)(B)(ii) thereof; or

(2) a spouse who is a member of the same household as the miner, or is receiving regular contributions from the miner for his support, or whose spouse is a miner who has been ordered by a court to contribute to his support, or who meets the requirements of section 216(b)(1) or (2) or section 216(f)(1) or (2) of the Social Security Act. The determination of an individual's status as the "spouse" of a miner shall be made in accordance with the determination of a wife, husband, widow, or widower under section 216(h)(1) of the Social Security Act as if such miner were the "insured individual" referred to therein. The term "spouse" also includes a divorced spouse who has been married to such individual for a period of 10 years immediately before the date the divorce a vinculo matrimonii became effective, and who is receiving at least one-half of his support, as determined in accordance with regulations prescribed by the Secretary, from the miner, or is receiving substantial contributions from the miner (pursuant to a written agreement), or there is in effect a court order for substantial contributions to his support from such miner;

(b) the term "Secretary" means the Secretary of Health, Education, and Welfare;

(c) the term "radiation-induced disease" includes lung cancer, bronchogenic cancer, cancers involving the respiratory or lymphopoietic system, and any other disease which the Secretary concludes is radiation-induced and which resulted from employment as a uranium miner;

(d) the term "dust-induced latent disease" includes pulmonary fibrosis, silicosis, and corpulmonale, and any other disease which the Secretary concludes is a dust-induced latent disease which resulted from employment as a uranium miner;

(e) the term "miner" means any individual who worked in or on the premises of a uranium mine or uranium preparation facility in the extraction or preparation of uranium. Such term includes underground and surface uranium miners, uranium millers, and individuals engaged in maintenance and repair of such facilities;

(f) the terms "widow" and "widower" include the spouse living with or dependent for support on the miner at the time of his death, or living apart for reasonable cause or because of his desertion, or who meets the requirements of section 216(c)(1), (2), (3), (4), or (5) or 216(g)(1), (2), (3), (4) or (5), and section 216(k) of the Social Security Act, who is not married. The determination of an individual's status as the "widow" or "widower" of a miner shall be made in accordance with section 216(h)(1) of the Social Security Act as if such miner were the "insured individual" referred to therein. Such term also includes a surviving divorced spouse who is divorced a vinculo matrimonii from an individual who has died who for the month preceding the month in which the miner died, was receiving at least one-half of his support, as determined in accordance with regulations prescribed by the Secretary, from the miner, or was receiving substantial contributions from the miner (pursuant to a written agreement) or there was in effect a court order for substantial contributions to his support from the miner at the time of his death;

(g) the term "total disability" has the meaning given it by regulations of the Secretary of Health, Education, and Welfare for claims under this Act subject to the relevant provisions of subsections (b) and (d) of section 6 of this Act, except that—

(1) in the case of a living miner, such regulations shall provide that a miner shall be considered totally disabled when a radiation-induced or dust-induced latent disease prevents him from engaging in gainful employment requiring the skills and abilities comparable to those of any employment in a mine or mines in which he previously engaged with some regularity and over a substantial period of time;

(2) such regulations shall provide that (A) a deceased miner's employment in a mine at the time of death shall not be used as conclusive evidence that the miner was not totally disabled; and (B) in the case of a living miner if there are changed circumstances of employment indicative of reduced ability to perform his usual uranium-mine work, such miner's employment in a mine shall not be used as conclusive evidence that the miner is not totally disabled;

(3) such regulations shall not provide more restrictive criteria than those applicable under section 223(d) of the Social Security Act; and

(4) the Secretary, in consultation with the Director of the National Institute for Occupational Safety and Health, shall establish criteria for all appropriate medical tests under this subsection which accurately reflect total disability in uranium miners as defined in subparagraph (1); and

(b) the term "child" means a child or a step-child who is—

(1) unmarried; and

(2)(A) under eighteen years of age; or

(B)(i) under a disability as defined in section 223(d) of the Social Security Act;

(ii) which began before the age specified in section 202(d)(1)(B)(ii) of the Social Security Act, or, in the case of a student, before he ceased to be a student; or

(C) a student.

The term "student" means a "full-time student" as defined in section 202(d)(7) of the Social Security Act, or a "student" as defined in section 8101(17) of title 5, United States Code. The determination of an individual's status as the "child" of the miner or widow or widower, as the case may be, shall be made in accordance with section 216(h)(2) or (3) of the Social Security Act as if such miner, widow, or widower were the "insured individual" referred to therein.

Sec. 4. (a) The Secretary shall, in accordance with the provisions of this Act, and the regulations promulgated under this Act, make payments of benefits in respect of total disability of any miner due to a radiation-induced or dust-induced latent disease, and in respect of the death of any miner whose death was due to a radiation-induced or dust-induced latent disease or who at the time of his death was totally disabled by a radiation-induced or dust-induced latent disease, if such miner was employed for at least three years in one or more uranium mines prior to the full implementation of the final regulations promulgated pursuant to the Federal Metal and Nonmetallic Mine Safety Act prior to its repeal under the Federal Mine Safety and Health Act of 1977.

(b) The Secretary shall by regulation prescribe standards for determining for purposes of subsection (a), whether a miner is totally disabled due to a radiation-induced or dust-induced latent disease and for determining whether the death of a miner was due to a radiation-induced or dust-induced latent disease. Regulations required by this subsection shall be promulgated and published in the Federal Register at the earliest practicable date after the date of enactment of this Act, and in no event later than the end of the third month following the month in which this Act is enacted. Final regulations required for implementation of any amendments to this Act shall be promulgated and published in the Federal Register at the earliest practicable date after the date of enactment of such amendments, and in no event later than the end of the third month following the month in which such amendments are enacted. Such regulations may be modified or additional regulations promulgated from time to time thereafter.

(c) For purposes of this section—

(1) If a miner who is suffering or suffered from a radiation-induced disease was employed for three years or more in one or more uranium mines prior to the full implementation of the final regulations promulgated pursuant to the Federal Metal and Nonmetallic Mine Safety Act prior to its repeal under the Federal Mine Safety and Health Act of 1977, there shall be a rebuttable presumption that his radiation-induced disease arose out of such employment.

(2) If a deceased miner was employed for three years or more in one or more uranium mines prior to the full implementation of the final regulations promulgated pursuant to the Federal Metal and Nonmetallic Mine Safety Act prior to its repeal under the Federal Mine Safety and Health Act of 1977, and died from a radiation-induced disease, there shall be a rebuttable presumption that his death was due to a radiation-induced disease.

(3) If a miner who is suffering or suffered from a dust-induced latent disease was employed for three years or more in one or more uranium mines prior to the full implementation of the final regulations promulgated pursuant to the Federal Metal and Nonmetallic Mine Safety Act prior to its repeal under the Federal Mine Safety and Health Act of 1977, there shall be a rebuttable presumption that his dust-induced latent disease arose out of such employment.

(4) If a deceased miner was employed for three years or more in one or more uranium mines prior to the full implementation of the final regulations promulgated pursuant to the Federal Metal and Nonmetallic Mine Safety Act prior to its repeal under the Federal Mine Safety and Health Act of 1977, and died from a dust-induced latent disease, there shall be a rebuttable presumption that his death was due to a dust-induced latent disease.

(5) In the case of a miner who dies on or before the date of the enactment of this Act who was employed for three years or more in one or more uranium mines prior to the final regulations promulgated pursuant to the Federal Metal and Nonmetallic Mine Safety Act prior to its repeal under the Federal Mine Safety and Health Act of 1977, the eligible survivors of such miner shall be entitled to the payment of benefits, at the rate applicable under section 5(a)(2), unless it is established that at the time of his death such miner was not partially or totally disabled due to a radiation-induced latent disease. Eligible survivors shall, upon request by the Secretary, furnish such evidence as is available with respect to the health of the miner at the time of his death.

(d) Nothing in subsection (c) shall be deemed to affect the applicability of subsection (a) in the case of a claim where the presumptions provided for therein are inapplicable.

Sec. 5. (a) Subject to the provisions of subsection (b) of this section, benefit payments shall be made by the Secretary under this part as follows:

(1) In the case of total disability of a miner due to a radiation-induced or dust-induced latent disease, the disabled miner shall be paid benefits during the disability at a rate equal of 60 percent of the minimum

monthly payment to which a Federal employee in grade GS–2, who is totally disabled, is entitled at the time of payment under chapter 81 of title 5, United States Code.

(2) In the case of death of a miner due to a radiation-induced or dust-induced latent disease or of a miner receiving benefits under this Act, benefits shall be paid to such miner's widow or widower (if any) at the rate the decreased miner would receive such benefits if he were totally disabled.

(3) In the case of the child or children of a miner whose death is due to a radiation-induced or dust-induced latent disease or of a miner who is receiving benefits under this Act at the time of his death, or who was totally disabled by a radiation-induced or dust-induced latent disease at the time of his death, in the case of the child or children of a widow or widower who is receiving benefits under this Act at the time of such widow's or widower's death, and in the case of any child or children entitled to the payment of benefits under paragraph (5) of section 4(c), benefits shall be paid to such child or children as follows: If there is one such child, he shall be paid benefits at the rate specified in paragraph (1). If there is more than one such child, the benefits paid shall be divided equally among them and shall be paid at a rate equal to the rate specified in paragraph (1), increased by 50 percent of such rate if there are two such children, by 75 percent of such rate if there are three such children, and by 100 percent of such rate if there are more than three such children, except that benefits shall only be paid to a child for so long as he meets the criteria for the term "child" contained in section 3(g), and no entitlement to benefits as a child shall be established under this paragraph for any month for which entitlement to benefits as a widow or widower is established under paragraph (2).

(4) In the case of an individual entitled to benefit payments under paragraph (1) or (2) of this subsection who has one or more dependents, the benefit payments shall be increased at the rate of 50 percent of such benefit payments, if such individual has one dependent, 75 percent if such individual has two dependents, and 100 percent if such individual has three or more dependents.

(5) In the case of—

(A) the dependent parent or parents of a miner whose death is due to a radiation-induced or dust-inducted latent disease, or of a miner who is receiving benefits under this part at the time of his death, or of a miner who was totally disabled by a radiation-induced or dust-induced latent disease at the time of death, and who is not survived at the time of his death by a widow or a widower or a child;

(B) the dependent surviving brothers or sisters of such a miner who is not survived at the time of his death by a widow, widower, child, or parent;

(C) the dependent parent or parents of a miner (who is not survived at the time of his or her death by a widow, widower, or a child), who are entitled to the payment of benefits under paragraph (5) of section 4(c); or

(D) the dependent surviving brothers or sisters of a miner (who is not survived at the time of his or her death by a widow, widower, child, or parent) who are entitled to the payment of benefits under paragraph (5) of section 4(c);

Benefits shall be paid under this part to such parents, or to such brothers, sisters, at the rate specified in paragraph (3) (as if such parents or such brothers or sisters, were the children of such miner). In determining for purposes of this paragraph whether a claimant bears the relationship as the miner's parent, brother, or sister, the Secretary shall apply legal standards consistent with these applicable to relationship determination under title II of the Social Security Act. Benefits shall be payable under this paragraph to a brother or sister only if he or she is—

(A) (i) under eighteen years of age, or

(ii) under a disability as defined in section 223 (d) of the Social Security Act which began before the age specified in section 202 (d) (1) (B) (ii) of such Act, or in the case of a student, before he ceased to be a student, or

(iii) a student as defined in section 3(h) of this Act, or

(E) who is, at the time of the miner's death, disabled as determined in accordance with section 223(d) of the Social Security Act, during such disability. No benefits to a sister or brother shall be payable under this paragraph for any month beginning with the month in which he or she receives support from his or her spouse, or marries. Any benefit under this paragraph for a month prior to the month in which a claim for such benefit is filed shall be reduced to any extent that may be necessary, so that it will not render erroneous any benefit which, before the filing of such claim, the Secretary has certified for payment for such prior months. As used in this paragraph, "dependent" means that during the one year period prior to and ending with such miner's death, such parent, brother, or sister was living in the miner's household, and was, during such period, totally dependent on the miner for support. Proof of such support shall be filed by such claimant within two years after the date of the enactment of this Act, or within two years after the miner's death, whichever is the later. Any such proof which is filed after the expiration of such period shall be deemed to have been filed

How will a standard be implemented
what will be reg. of U- mines

within such period if it is shown to the satisfaction of the Secretary that there was good cause for failure to file such proof within such period. The determination of what constitutes "living in the miner's household," "totally dependent upon the miner for support," and "good cause," shall for purposes of this paragraph be made in accordance with regulations of the Secretary. Benefit payments under this paragraph to a parent, brother, or sister, shall be reduced by the amount by which such payments would be reduced on account of excess earnings of such parent, brother, or sister, respectively, under section 203(b)(1) of the Social Security Act, as if the benefit under this paragraph were a benefit under section 202 of such Act.

(6) If an individual's benefits would be increased under paragraph (4) of this subsection because he or she has one or more dependents, and it appears to the Secretary that it would be in the interest of any such dependent to have the amount of such increase in benefits (to the extent attributable to such dependent) certified to a person other than such individual, then the Secretary may, under regulations prescribed by him, certify the amount of such increase in benefits (to the extent so attributable) not to such individual but directly to such dependent or to another person for the use and benefit of such dependent. Any payment made under this paragraph, if otherwise valid under this Act, shall be in complete settlement and satisfaction of all claims, rights, and interests in and to such payment.

(b) Notwithstanding subsection (a), benefit payments under this section to a miner or such miner's widow, widower, child, parent, brother, or sister shall be reduced, on a monthly or other appropriate basis, by an amount equal to any payment received by such miner or such miner's widow, widower, child, parent, brother, or sister under the workmen's compensation, unemployment compensation, or disability insurance laws of his State on account of the disability of such miner due to a radiation-induced or dust-induced latent disease, and the amount by which such payment would be reduced on account of excess earnings of such miner under section 203 (b) through (l) of the Social Security Act if the amount paid were a benefit payable under section 202 of such Act. This Act shall not be considered a workmen's compensation law or plan for purposes of section 224 of such Act.

(c) Benefits payable under this Act shall be deemed not to be income for purposes of the Internal Revenue Code of 1954.

(d)(1) In the case of an individual, who prior to filing a claim for benefits under this Act, has on account of the disease on which such claim is based received compensation or damages from an employer or other person (under a governmental program or agency) based on a tort claim, the benefit payments to such individual under this section shall be reduced (but not below zero) in accordance with regulations of the Secretary for each month until the aggregate of such reductions equals the amount of such compensation or damages so received; except that such reductions shall be made, in the case of any individual, only to the extent that, considering the financial circumstances and needs of the claimant, the making of such reductions would not defeat the purposes of this Act nor be against equity and good conscience.

(2) In the case of an individual, who after having received benefit payments for one or more months under this Act, receives compensation or damages on account of the disease on which such payments are based from an employer or other person (including a governmental program or agency), such individual shall be liable to repay to the United States (and the United States shall be entitled to recover from such individual) an amount equal to whichever of the following is the lesser (A) the amount of the compensation or damages received by such individual, or (B) an amount equal to the aggregate of the benefit payments which such individual has received under this Act for all months prior to the month after the month such amount was so received by him. If the amount of such compensation or damages is in excess of the amount of the recovery provided for in the preceding sentence, the benefit payments payable to such individual under this Act, beginning with the month immediately following the last month included within the period with respect to which recovery is so provided for, shall be reduced (but not below zero) in accordance with regulations of the Secretary for each month until the aggregate of such reductions equals the amount of such excess; except that such reductions under this sentence shall be made, in the case of any individual, only to the extent that, considering the financial circumstances and needs of the claimant, the making of such reductions would not defeat the purposes of this Act nor be against equity and good conscience.

(3) Whenever an amount of compensation or damages (based on the death or disability of a miner), referred to in paragraph (1), is received by one individual who is eligible for benefits under this Act, an appropriate portion of such amount (as determined under regulations of the Secretary) shall be regarded, for purposes of paragraphs (1) and (2), to have been paid to another individual who is eligible (on the basis of death or disease of such miner), if and to the extent that such other individual shared in or benefitted from such amount (as determined under such regulations).

SEC. 6. (a) No payment of benefits shall be made under this Act except pursuant to a claim filed therefor, in such manner, in such form, and containing such information, as the Secretary shall by regulation prescribe.

(b) In carrying out the provisions of this Act, the Secretary shall to the maximum extent feasible utilize the personnel and procedures he uses in determining entitlement to disability insurance benefit payments under section 223 of the Social Security Act, but no claim for benefits under this Act shall be denied solely on the basis of the results of a chest roentgenogram. In determining the validity of claims under this Act, all relevant evidence shall be considered, including, all relevant medical tests, any medical history, evidence submitted by the claimant's physician, or the claimant's spouse's affidavits, and in the case of a deceased miner, other appropriate affidavits of persons with knowledge of the miner's physical condition, and other supportive materials. Where there is no medical or other relevant evidence in the case of a deceased miner, such affidavits shall be considered to be sufficient to establish that the miner was

totally disabled due to a radiation-induced or dust-induced latent disease or that his death was due to a radiation-induced or dust-induced latent disease. Unless the Secretary has good cause to believe that an autopsy report is not accurate, or that the condition of the miner is being fraudulently misrepresented, the Secretary shall accept such autopsy report concerning the presence of a radiation-induced or dust-induced latent disease and the stage of advancement of a radiation-induced or dust-induced latent disease. Claimants under this Act shall be reimbursed for reasonable medical expenses incurred by them in establishing their claims. For purposes of determining total disability under this Act, the provisions of subsections (a), (b), (c), (d), and (g) of section 221 of the Social Security Act shall be applicable. The provisions of sections 204, 205 (a), (b), (d), (e), (g), (h), (j), (k), (l) and (n), 206, 207, and 208 of the Social Security Act shall be applicable under this Act with respect to a miner, widow, widower, child, parent, brother, sister, or dependent, as if benefits under this Act were benefits under title II of the Social Security Act. Each miner who files a claim for benefits under this title shall upon request be provided an opportunity to substantiate his claim by means of a pulmonary and respiratory evaluation or by any other appropriate medical evaluations needed to substantiate radiation or dust-induced latent disease.

(c) No claim for benefits for dust-induced latent disease under this section shall be considered unless the claimant has also filed a claim under the applicable State workmen's compensation law prior to or at the same time his claim was filed for benefits under this section, except that such filing shall not apply in any case in which the filing of a claim under such law would clearly be futile because the period within which such a claim may be filed thereunder has expired or because dust-induced latent diseases are not compensable under such law, or in any other situation in which, in the opinion of the Secretary, the filing of a claim would clearly be futile.

(d) No miner who is engaged in uranium mine employment shall (except as provided in section 4(c)(3)) be entitled to any benefits under this Act while so employed. Any miner who has been determined to be eligible for benefits pursuant to a claim filed while such miner was engaged in uranium mine employment shall be entitled to such benefits if his employment terminates within one year after the date such determination becomes final.

(e) No benefits under this Act shall be payable for any period prior to the date a claim therefor is filed.

(f) No benefits shall be paid to residents of any State, which, after the date of the enactment of this Act, reduces the benefits payable to persons eligible to receive benefits under this Act, under its State laws which are applicable to its general work force with regard to workmen's compensation, unemployment compensation, or disability insurance.

(g) No benefits shall be payable to a widow, parent, brother, or sister under this Act on account of the death of a miner unless—

(1) benefits under this Act were being paid to such miner with respect to disability due to a radiation-induced or dust-induced latent disease; or

(2) any such individual is entitled to benefits under paragraph (5) of section 4(c).

(h) The United States shall furnish to any miner eligible to receive benefits under this Act, the services, appliances, and supplies prescribed or recommended by a qualified physician, which the Secretary considers likely to cure, give relief, or reduce the degree or period of disability. Such services, appliances, and supplies shall be furnished—

(1) whether or not disability has arisen; and

(2) by or on the order of United States medical officers and hospitals, or, at the miner's option, by or on order of physicians and hospitals designated or approved by the Secretary.

The miner may initially select a physician to provide medical services, appliances, and supplies, in accordance with such regulations and instructions as the Secretary considers necessary, and may be furnished necessary and reasonable transportation and expenses incident to securing such services, appliances, and supplies.

SEC. 7. (a) The Secretary of Health, Education, and Welfare is authorized to issue such regulations as he deems appropriate to carry out the provisions of this Act. Such regulations shall be issued in conformity with section 553 of title 5 of the United States Code, notwithstanding subsection (a) thereof.

(b) Within 120 days following the convening of each session of Congress the Secretary of Health, Education, and Welfare shall submit to the Congress an annual report on the subject matter of this Act.

(c) Nothing in this title shall relieve any operator of any uranium mine of the duty to comply with any State workmen's compensation law, except insofar as such State law is in conflict with the provisions of this Act and the Secretary by regulation, so prescribes. The provisions of any State workmen's compensation law which provide greater benefits than the benefits payable

Joe any way to reach 3000 + miners?

under this Act shall not thereby be construed or held to be in conflict with the provisions of this title.

SEC. 8. (a) The Secretary is authorized to enter into contracts with, and make grants to, public and private agencies and organizations and individuals for the construction, purchase, and operation of fixed-site and mobile clinical facilities for the analysis, examination, and treatment of radiation-induced and dust-induced latent diseases and impairments. The Secretary shall coordinate the making of such contracts and grants with the Director of the National Institute for Occupational Safety and Health.

(b)(1) The Secretary is authorized to make research grants to public and private agencies and organizations and individuals for the purpose of devising simple and effective tests to measure, detect, and treat radiation-induced and dust-induced latent diseases and impairments. The Secretary shall coordinate the making of such contracts with the Director of the National Institute for Occupational Safety and Health. Any grant made pursuant to this subsection shall be conditioned upon all information, uses, products, processes, patents, and other developments resulting from such research being available to the general public, except to the extent of such exceptions and limitations as the Secretary may deem necessary in the public interest.

(2) The Secretary and the Secretary of Labor in consultation with the Director of the National Institute of Occupational Safety and Health are authorized to jointly enter into contracts with, and make grants to, private organizations and individuals with demonstrated expertise in health problems of uranium miners, to evaluate the effects of the allowable radiation exposure of four working level months as stipulated by the Mine Safety and Health Act Amendments of 1977 upon the health of uranium miners.

(c) The Secretary and the Secretary of Labor in consultation with the Director of the National Institute of Occupational Safety and Health shall undertake, through appropriate organizations, groups, and uranium mine operators, to notify individuals who are likely to be eligible for benefits of the availability of such benefits. Such notification shall include a program to inform miners who may not have yet contracted a radiation-induced or dust-induced latent disease of the hazards to which they had been exposed. Such notification programs shall provide such information in simple and direct language and, where applicable, translate such information into the native language of the individuals to be notified.

(d) There is hereby authorized to be appropriated for the purpose of subsection (a) of this section such sums as may be necessary for each fiscal year. There are hereby authorized to be appropriated for the purposes of subsections (b) and (c) of this section such sums as are necessary to carry out such subsections.

SEC. 9. (a) No operator of any uranium mine shall discharge or in any other way discriminate against any miner employed by him by reason of the fact that such miner is suffering from a radiation-induced or dust-induced latent disease. No person shall cause or attempt to cause an operator to violate this section. For the purposes of this subsection the term "miner" shall not include any person who has been found to be totally disabled.

(b) Any miner who believes that he has been discharged or otherwise discriminated against by any person in violation of subsection (a) of this section, or any representative of such miner may, within ninety days after such violation occurs, apply to the Secretary for a review of such alleged discharge or discrimination. A copy of the application shall be sent to such person who shall be the respondent. Upon receipt of such application, the Secretary shall cause such investigation to be made as he deems appropriate. Such investigation shall provide an opportunity for a public hearing at the request of any party to enable the parties to present information relating to such violation. The parties shall be given written notice of the time and place of the hearing at least five days prior to the hearing. Any such hearing shall be of record and shall be subject to section 554 of title 5 of the United States Code. Each hearing examiner presiding under this section shall receive compensation at a rate not less than that prescribed for GS-16 under section 5332 of title 5, United States Code. Upon receiving the report of such investigation, the Secretary shall make findings of fact. If he finds that such violation did occur, he shall issue a decision, incorporating an order therein, requiring the person committing such violation to take such affirmative action as the Secretary deems appropriate, including, but not limited to, the rehiring or reinstatement of the miner to his former position with back pay. If he finds that there was no such violation, he shall issue an order denying the application. Such order shall incorporate the Secretary's findings therein.

(c) Whenever an order is issued under this subsection granting relief to a miner at the request of such miner, a sum equal to the aggregate amount of all costs and expenses (including the attorney's fees) as determined by the Secretary to have been reasonably incurred by such miner for, or in connection with, the institution and prosecution of such proceedings, shall be assessed against the person committing the violation.

(d) Any person who willfully makes any false or misleading statement or representation for the purpose of obtaining any benefit or payment under this Act shall be guilty of a misdemeanor and on conviction thereof shall be punished by a fine of not more than $1,000, or by imprisonment for not more than one year, or both.

(e) The Secretary shall by regulation require employers to file reports concerning miners who may be or are entitled to benefits under this Act, including the date of commencement and cessation of benefits and the amount of such benefits. Any such report shall not be evidence of any fact stated therein in any proceeding relating to death or total disability due to a radiation-induced or dust-induced latent disease of any miner to which such report relates.

(f) Any employer who fails or refuses to file any report required of such employer under this section shall be subject to a civil penalty of not more than $500 for each such failure or refusal.

SEC. 10. Any individual whose claim for benefits under this Act is denied shall receive from the Secretary a written statement of the reasons for denial of such claim, and a summary of the administrative hearing record or, upon good cause shown, a copy of any transcript thereof.

SEC. 11. The Secretary shall, immediately following the end of each fiscal year, report to the Congress concerning the implementation of this Act. Such report shall include an account of the activities, accomplishments and progress of the benefits program established by this Act.

The ACTING PRESIDENT pro tempore. It will be appropriately referred.

Mr. DOMENICI. I thank the Chair and I yield back the remainder of my time.

URANIUM MINERS COMPENSATION

HEARINGS

BEFORE THE

SELECT SUBCOMMITTEE ON LABOR

OF THE

COMMITTEE ON EDUCATION AND LABOR

HOUSE OF REPRESENTATIVES

NINETIETH CONGRESS

SECOND SESSION

ON

H.R. 14558 and H.R. 16302

BILLS TO AUTHORIZE THE SECRETARY OF LABOR TO PROVIDE SUPPLEMENTARY COMPENSATION FOR PERMANENT TOTAL DISABILITY OR DEATH FROM LUNG CANCER RESULTING FROM EXPOSURE TO IONIZING RADIATION IN URANIUM MINES; TO PROVIDE GRANTS TO STATES FOR RESEARCH AND PLANNING WITH RESPECT TO IONIZING RADIATION INJURIES IN URANIUM MINES; AND FOR OTHER PURPOSES

HEARINGS HELD IN WASHINGTON, D.C., APRIL 1, 4, AND MAY 1, 1968

Printed for the use of the Committee on Education and Labor
CARL D. PERKINS, *Chairman*

U.S. GOVERNMENT PRINTING OFFICE
94-425 O WASHINGTON : 1968

Labor to make arrangements with the States for the payment of benefits.

In defining the class of miners eligible for these federally funded benefits, H.R. 14558 offers the broader definition in that the period of qualifying employment is from April 1, 1948, until 5 years after enactment of the bill. H.R. 16302 would cut off at December 31, 1970, the date when Government contracts for the purchase of uranium concentrates expire.

H.R. 16302, from the technical point of view, provides a more definitive provision dealing with the matter of limitations on the time for filing claims. H.R. 16302, section 201, provides for reimbursement to States for compensation benefits paid by the State for exposures incurred during the period April 1, 1948, to December 31, 1961. H.R. 14558 has no similar provision.

Although both bills provide for reports by States to the Secretary of Labor on the grant program, H.R. 16302 also provides for an annual report to the Congress.

In several sections of H.R. 14558 the words "while working" are used in defining the class of miners eligible for benefits. In like places H.R. 16302 uses the words "during their employment." We favor the wording of H.R. 14558 on this point, in that it will avoid a technical question of employment status. For example, some mines are owner or family operated and do not result in a true employer-employee relationship within the meaning of workmen's compensation and occupational disease law statutes.

In concluding my statement I would like to reiterate the Commission's support for Federal assistance to uranium miners who are so unfortunate as to develop lung cancer as the result of mining the ores to meet the defense needs of this country.

If there are any questions, my colleagues and I will be pleased to answer them.

Mr. O'HARA. Thank you very much, Commissioner.

Mr. Steiger, do you have any questions?

Mr. STEIGER. No, Mr. Chairman, I have no questions. I appreciate the Commissioner's testimony here this morning.

Mr. O'HARA. Commissioner, I would like to ask you just a couple of questions.

I would appreciate it if you could explain the system you just referred to at the top of page 4 of your statement, the system you use to encourage and help bear the cost of insurance coverage for employees of contractors operating AEC-owned facilities.

How does that work?

Mr. RAMEY. Well, the Commission does practically all of its business through operating contractors who operate these Government-owned facilities. It has laboratories, its production plants, and so on, so that the Commission has about 7,000 employees, and our operating contractors have over 100,000.

These contracts are cost-type contracts with industrial, university, and nonprofit-type organizations. Under the provisions of these contracts we provide, usually, for the contractors to supplement their workmen's compensation arrangements by waiver of limiting State provisions affecting workmen's compensation in the States in which

the contractors are operating, and the AEC pays the additional cost involved.

Mr. O'HARA. If you have a cost-plus contract, you would simply let him include that among his costs, is that right?

Mr. RAMEY. Yes; that is right.

Mr. O'HARA. Do you insist that he have such coverage, or not?

Mr. RAMEY. I would say we adopted a policy along this line very early in the game. Actually, the Manhattan district, of the War Department, which started the original nuclear program in the 1940's, started this policy, and the Commission adopted it very strongly, and put out a policy statement, as I recall, in 1952.

So I wouldn't say it is necessarily mandatory, but I think everybody does it.

Mr. O'HARA. I presume that this wouldn't work with uranium mines, because you are not the purchaser of the ore from the mine, are you?

Mr. RAMEY. Not at this time, and we haven't been for a number of years. We purchase the ore from the mills, and the mills procure it from the mines.

In the original contracts, there was some direct purchase. And these are also, of course, more of the fixed-price type of contractual arrangements between the AEC and the mills, rather than a cost-type operating arrangement, as we have in our operating contracts.

Mr. O'HARA. That is right.

In fact, that has been one of the problems with the mines all along. I can recall well when we had the series of hearings in the two congressional acts dealing with mine safety that we frequently referred to the subject of having the Federal Government simply impose some standards with respect to the amount of radon gas and the levels of exposure in the mines, and the stumbling block we always ran up against was the fact that there was no direct contractual relationship between the mines and the U.S. Government, although I see Secretary Wirtz felt that he has authority under Walsh-Healy to insist on certain standards. Is that correct?

Mr. RAMEY. Yes, in the AEC contracts with the mills, there was a standard Walsh-Healy Act provision that the Labor Department construed as going back to their arrangements on the procurement of the ore, and this has apparently been followed.

As a matter of fact, I suggested that the AEC, back in 1962 in its stretch-out contracts, might put in a provision establishing radiation standards in the mines, but at that time conditions were rather different in that many mines were shutting down and so on, and it was decided not to get into such a negotiating problem.

Mr. O'HARA. In your testimony, you speak of 1970 as being the expiration date of Government contracts for the purchase of uranium concentrates.

Mr. RAMEY. Yes, sir. The original date for the expiration of these contracts was 1966, and we in 1962 entered into what we call our stretch-out program, in which the mines and the mills agreed to cut down their production about 50 percent and stretch the program out for 4 years.

So it took it through 1970.

Mr. O'HARA. Is that a significant date? In other words, is there

For comparison, 10 years at a working level of 2 results in a cumulative exposure of 240 Working-Level-Months. At this time the Federal Radiation Council has conclude that "the data are not sufficient to indicate an association between exposure to radon daughters and the subsequent development of lung cancer when the cumulative exposures are less than about 1,000 WLM." (Quote from page 20, "Report No. 8 Revised, Guideline for the Control of Radiation Hazards in Uranium Mining", September, 1967, Staff Report of the Federal Radiation Council).

III. HISTORY OF EARLY URANIUM MINERS

The Subcommittee questioned why Colorado is in trouble, and the other states are not (page 136 of the Transcript of Hearings).

The following excerpt from Part 2 of the "Hearings before the Subcommittee on Research Development, and Radiation of the Joint Committee on Atomic Energy, Congress of the United States", Appendix 3, Chart 6, Page 907, illustrate the reason one would suspect the majority of the lung cancer cases to develop among the miners who worked in Colorado during the 1950's and late 1940's.

1958 RADON DAUGHTER MEASUREMENTS

State	Number or miners	Number of mines	Percent of samples in working level range				Median working level
			Less than 1	1 to 3	3 to 10	More than 10	
Arizona	148	17	17	12	27	44	8.3
Colorado	1,267	219	.....	[1]37	[1]37	[1]28	4.6
New Mexico	700	29	50	22	19	9	1.0
Utah	874	115	28	49	14	9	1.5
Wyoming	14	1	.....				

1959 RADON DAUGHTER MEASUREMENTS

Arizona	220	24	25	25	30	20	2.9
Colorado	1,208	195	21	17	26	36	6.1
New Mexico	1,333	43	44	25	18	13	1.5
Utah	770	95	32	24	25	19	2.5
Wyoming	74	11	17	33	33	17	2.9

[1] No explanation why total is equal to 102 percent.

The Colorado Mining Association will be happy to attempt to collect any further information which the Subcommittee might desire on the problem involving lung cancer in uranium miners.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
PUBLIC HEALTH SERVICE,
May 17, 1968.

MR. JAMES B. HARRISON,
House Select Labor Subcommittee,
Rayburn House Office Building,
Washington, D.C.

DEAR MR. HARRISON: Enclosed are the reports on the status of uranium mines which have been prepared annually for some years. These reports are not complete as small operations opened and closed between visits by an inspector. In some states, inspections were only made annually or semi-annually.

Sincerely,

DUNCAN A. HOLADAY,
Sanitation Engineer Director (Retired),
Consultant, P.H.S.

[Enclosures.]

RADON CONTROL IN URANIUM MINES

(Summary of 1961 Activities)

The health hazards involved in the mining of uranium were discussed at a conference of the governors of the uranium-producing states held in Denver on December 16, 1960. Following this conference several of the states instituted

radiation control programs, and others increased the activities in which they were already engaged. Many mining companies also initiated programs or intensified their control efforts. This report has been prepared to summarize the work that has been done and, where possible, to evaluate the present situation in uranium mines. In most cases, the information used in preparing this summary was obtained by state agencies, though some of the data came from U.S. Bureau of Mines or private company surveys.

COLORADO

Colorado received additional money from the legislature which enabled the Bureau of Mines to initiate a radiation control program. The details of this program and a discussion of the results are summarized in a progress report dated December 7, 1961. A copy of this document is attached to this report as Appendix I. Table I lists information on the status of Colorado Mines, together with similar information obtained in 1960.

TABLE I

Working level range	1960		July 1, 1961		Dec. 1, 1961	
	Number of mines	Percent	Number of mines	Percent	Number of mines	Percent
Less than 1	23	23	29	18	93	45
1 to 2.9	26	26	22	14	52	25
3 to 9.9	19	20	45	29	52	25
Over 10	31	31	62	39	11	5
Total	99		158		208	

Mines were assigned to Working Level Ranges on the basis of the *average* of the radon daughter concentrations measured in the mine during the survey antedating the time of the report (there may have been several surveys during the reporting period, but only the most recent was used). This mine average figure *does not* represent the exposure of the miners, but is useful to indicate the general condition of the mines, and to indicate which operations need the most attention. The data presented in Table I is not necessarily representative of all uranium mines in Colorado, as about 400 uranium mines will be worked at some time during any one year and it was possible to survey only a portion of these during any reporting period.

The data show that there has been a marked lowering of the mine average radon daughter concentrations in the Colorado mines surveyed. The state and the industry use the recommendations of the American Standard for Uranium Mines and Concentrators[1] as a guide and have been primarily directing attention to those situations where controls are most needed. The reduction of the number of mines in the "more than 10 x Working Level" range is especially significant.

ARIZONA

The nature of the uranium mining industry in Arizona is quite different from that in Colorado. Relatively, there are only a few mines, of which all but one are on Indian lands. At present several of the mines are "clean-up" operations in which pillar and pockets of marketable ore are being removed. Such mines are very difficult to ventilate and activity in any one is sporadic. Thus, while the number of mines has not changed markedly in the last two years, the composition of the group has.

The Arizona state mine inspector attempts to survey all the mines twice a year. This office did not receive any additional funds in 1961 for this purpose, and so was not able to increase its activity. The U.S. Bureau of Mines also visits all the mines on Indian lands several times a year and recommends control measures where concentrations are found to exceed the working level. The data obtained in 1960 and 1961 are summarized in Table II, As with Colorado, the figures reported are the mine average radon Daughter concentration, as found in the latest survey in each year.

[1] American Standard for Uranium Mines and Mines (Concentrators) *N7.1–1960*.

Senator BINGAMAN. Thank you very much. Appreciate that statement.

Again, we will have some questions once we hear from the other two witnesses on this panel.

Our next witness is Dr. Leon Gottlieb, who is a clinician with the Santa Cruz County Health Services Agency in Santa Cruz, California. He is a pulmonary specialist who has authored a great many articles on this subject and has done extensive research on it for extensive periods of time.

We are very pleased that you have traveled from Santa Cruz to Shiprock today to give us your testimony.

STATEMENT OF DR. LEON GOTTLIEB, SANTA CRUZ COUNTY HEALTH SERVICES AGENCY

Dr. GOTTLIEB. Thank you. I, too, want to thank the Navajo Tribe, Senators and the Committee for testifying. I remember being a witness at the hearing 10, 11 years ago, meeting Senator Domenici, but I want to say a few words about the—and I want to refute the statement that the state of the art in the forties and fifties was such that there was not sufficient knowledge to implement mechanical ventilation and the knowledge of radiation hazards.

Well, this was certainly proven to be false, because we know that in the 15th century and in the 17th century, books were written about mining, and even ex-President Herbert Hoover translated a book on mining, which was written in the 16th century.

So we have all these experiences, and then the European experience, in which miners in the central European part of the country were exposed to uranium ores during the process of mining, and many of them became sick. In fact, it was called a German word, known as "bergkrankheit," which meant mountain sickness, and many of them came down with it, which was later proven, in 1897, to be cancer of the lung.

And we knew then that the European experience was not extrapolated, was not transferred to the American experience in the forties and fifties, where we know mining—ventilation in mines was not practiced correctly, but improperly, and was neglected, and we know that proper protection for the miners was never given to the miners. Warnings were never given to the miners.

In fact, many of the miners told me, in our clinic that we established here 11 years ago, that they would drink waters leeching through the walls of the mine, thus being exposed to radioactive liquids.

So then we have this situation; from that we go to the diseases that have appeared among uranium miners, and what I would like to do is classify them into two types: Malignant diseases of the lungs and nonmalignant diseases of the lungs, with malignant diseases of the lung, naturally, being cancer of the lung, and the nonmalignant being silicosis, which causes fibrosis, and then radiation pneumonitis, which also causes fibrosis.

Now, radiation in itself, radiation pneumonitis, can exacerbate or aggravate silicosis. The silicosis comes from the silica, which comes from the mine dust from quartz and granite and sandstone. And when this is inhaled, the lungs, the alveoli, the air sacs of the lung,

become impregnated with the dust, and thus respiration is interfered with.

Now, with radiation pneumonitis, the lungs are exposed to radioactive particles, the so-called radon daughters, and these radon daughters bombard the lungs and block and cause scar tissue to form in the lung tissue, thereby causing difficult and impaired breathing.

Our studies in 1982 show that out of 17 Navajos that were being checked out for lung cancer, that 16 were uranium miners, and then in 1984, our study was supplemented by Dr. Samet of the University of New Mexico Medical School, who showed a study of 32 Navajos, that 23 had developed lung cancer. These were 32 Navajo miners, and 23 had developed lung cancer.

And then, of course, Archer, in the seventies, also showed that there was a five fold increase of lung cancer among Navajo uranium miners.

So what I would like to say, in closing, to repeat an old Navajo saying, "May the good wind be at your back," and we hope that the Compensation Act goes through. Thank you.

Senator BINGAMAN. Thank you very much. Our final witness on this panel is Dr. Susan Dawson, who is with the Department of Sociology, Social Work and Anthropology at Utah State University in Logan, Utah. She has done extensive research on this very set of issues, and we are very pleased to have her here. Thank you.

STATEMENT OF DR. SUSAN E. DAWSON, DEPARTMENT OF SOCIOLOGY, SOCIAL WORK AND ANTHROPOLOGY, UTAH STATE UNIVERSITY

Dr. DAWSON. Mr. Chairman and Senator Domenici, thank you very much for having me here today to testify, and also to the Navajo people, who have accepted me into their homes.

I am a social work professor at Utah State University, and my doctorate is in social work with an emphasis in occupational and environmental health.

During the past year, I spent four months living and working with the Navajo people as part of a Utah State University research grant to study the psychosocial impacts of uncompensated occupational illnesses among Navajo uranium miners, uranium mill workers, and their families.

I conducted in-depth interviews with 48 people on the Navajo Reservation who live in Tuba City, Blue Gap, and the Shiprock areas.

As a group, the miners I interviewed worked in the uranium mines from the mid-1940s through the early 1980s. They had worked an average of 13 years in the mines and at the sites, primarily in drilling and laboring positions. These miners were dedicated workers who took pride in their work, despite its reported difficulty, working regular hours and often overtime to supplement their salaries.

The workers report that at no time were they informed of the dangers of radiation, nor were they informed of their rights under state workers' compensation laws when they did become ill. There were no safety signs and little formal instruction in general safety,

such as how to handle dynamite. None of the workers wore dosimeters or safety equipment until 1970, with the enactment of the Occupational, Safety and Health Act. Those workers who did work after 1970 reported an increase in worker safety and health practices, including the wearing of face masks and earplugs. Also, this was the first time they were required to leave their workclothes at the worksite.

Several miners explained that they were forced to enter the mines directly after blasting. All of the workers indicate that the mines were largely unventilated, that drinking water was collected from inside the mines, that they often ate their lunches, with unwashed hands, inside the mines and that they wore their dirty workclothes home for their spouses to wash with the family laundry. Air and water testing results, when collected, were never reported to the workers, and, consequently, they believed that the workplaces were safe.

For the first time in their lives, the workers, who prior to the uranium boom were largely agriculture workers, were earning high wages. The miners were transient in terms of their work histories, working a range of three to 25 different worksites located in the Four Corners area. They worked until the mines closed or their health failed. Many of the miners report that when the company learned that they were ill, following a health examination, they were fired without notice, severance pay, or sick pay benefits. Also, they were not encouraged to apply for unemployment compensation or workers' compensation. None of the workers were union members. Because the miners were transient, this no doubt led to diffusions of responsibility among their employers, and the uranium companies may have viewed the temporary workers as expendable, in terms of compensatory benefits.

The mill workers I interviewed lived in the Tuba City area and worked in the rare metals plant for an average of three years. Unlike the uranium miners, the mill workers were not a transient population but worked primarily at the mill plant. They directly handled unprocessed uranium ore and yellowcake, or milled ore, barehanded, and they repeatedly wore the same workclothes, often yellow with yellowcake, until they took them home to be washed. In Tuba City, the mill workers' homes at the site were recently demolished because the foundations had been built with radioactive mill tailings.

The miners' families often traveled with the miners and lived in housing established for them directly on the sites. Both the miners and the mill workers report that they used water from the area for drinking, bathing, and household uses. I was repeatedly told that the children of these workers played on the tailings and mill wastes from the worksites, often using the mines as their play areas.

Throughout the interviews, the lack of basic social service benefits and the knowledge of how to gain access to social services was evident. Most of the families interviewed lived in rural, often remote areas, without telephones. In addition, they often lack transportation or the financial means to buy gasoline, and thereby must rely on relatives to assist them. One widow, whose husband has been deceased for a year, receives no Social Security. Having

no income at all, she was asked how she survives. She said that she depends on her children.

For the families who have received social service benefits, the payment has often been sporadic. Many families had not entered claims for unemployment compensation and workers' compensation, saying they did not know they were eligible. While some families are dependent on their children for assistance, others rely on spouses' minimum wage employment and are barely able to survive. One woman explained to me that she eats only enough food to survive, to live. Families' resources also become strained when the family takes care of the sick worker in their homes.

Many of the workers had chronic long-term illnesses which required constant care on the part of family members. Illnesses reported by the workers include lung cancer, blood disorders, respiratory illnesses and birth defects of their children. Many of the workers did not understand their diagnoses and often referred to their illnesses as "chest problems." They were told, in many cases, that the cause of their illnesses was radiation-related. Almost all of the workers were unable to return to work or were greatly restricted in the type of work that they could do following their diagnoses.

The widows repeatedly explained how painful it is for them to hold the family together without their husbands. The Navajo are a people who live in clans and who are tied to the land. It is unusual for a Navajo family to relocate to another chapter area, thereby leaving the rest of the clan. Consequently, a family would not consider leaving the clan and the chapter because they provide both emotional and material support.

In addition to the psychosocial impacts of death or illness, the workers also report a sense of betrayal by the government and mine owners for placing them in an unsafe workplace. Several people related to me that they now question the government's commitment to the welfare of its citizens. Many of the Navajo told me that if they had known the potential health and environmental risks, they would not have undertaken employment which posed these risks both to themselves and to their families.

There is also stress from living in a chronic technological disaster area. One worker, who is suffering from cancer of the mouth and whose wife died of cancer, was relocated by the government three times because his hogan and subsequent two government-built homes were constructed from radioactive materials. A widow lives next to the rubble of her hogan and bread oven which were built of radioactive materials. She wonders if it is safe to have the rubble in her yard. Other people worry about the contamination of their water and air. The stress of living in a potentially unsafe environment is evident among many of the families.

Psychologically, the overall impact of the uranium mining and resulting health and environmental problems upon the Navajo have widespread implications. They view themselves and their world as an interconnected whole. This applies to religion, concepts of health, and how they perceive themselves in relation to the world. Consequently, a disruption in one part of their lives, be it their health or the land, creates an imbalance or disharmony on the overall system. The disruption, then, causes stress, not only be-

cause of the immediate problem to the individual, but because it threatens the disruption of the Navajo fabric of life and wholeness.

In summary, the government failed to meet its legal and moral obligations to these uranium workers in three ways: One, the government did not inform the workers of the inherent health risks of uranium mining. Two, the government failed to provide compensation to the workers and their families for the deaths and illnesses of the uranium workers. Three, the ecological damage created by the uranium mining and milling processes was not addressed for an extended period of time, thereby creating further health hazards.

The Navajo uranium miners and mill workers are proud people who worked in the nuclear industry for the defense of this country. They worked in good faith, believing that they were not endangered while the government failed in its responsibility to ensure the safety of their work. Providing compensation is the only humane recourse in redressing the wrongs incurred upon these workers and their families. Thank you very much.

[The prepared statement of Dr. Dawson follows:]

Statement of Susan E. Dawson, Ph.D.
Before the Mineral Resources Development and Production
Subcommittee of the Committee on Energy and Natural Resources

March 13, 1990

Mr. Chairman and Committee Members, thank you for the opportunity to testify today. My name is Dr. Susan Dawson and I am an assistant professor in the Department of Sociology, Social Work and Anthropology at Utah State University in Logan, Utah. My doctorate is in social work with an emphasis in occupational and environmental health.

During the past year, I spent four months living and working with the Navajo People as part of a Utah State University research grant to study the psychosocial impacts of uncompensated occupational illnesses among Navajo uranium miners, uranium mill workers, and their families. I conducted in-depth interviews with 48 people on the Navajo Reservation who live in Tuba City, Blue Gap, and the Shiprock area.

As a group the miners I interviewed worked in the uranium mines from the mid-1940's through the early 1980's. They had worked an average of 13 years at the sites - primarily in drilling and laboring positions. These miners were dedicated workers who took pride in their labor, despite its reported difficulty, working regular hours and often overtime to supplement their salaries.

The workers report that <u>at no time were they informed of the dangers of radiation nor were they informed of their</u>

rights under state workers' compensation laws when they become ill. There were no safety signs and little formal instruction in general safety, such as how to handle dynamite. None of the workers wore dosimeters or safety equipment until 1970 with the enactment of the Occupational, Safety and Health Act. Those workers who did work after 1970 reported an increase in worker safety and health practices, including the wearing of face masks and earplugs. Also, this was the first time they were required to leave their workclothes at the worksite.

Several miners explained that they were forced to enter the mines directly after blasting, when the mine was filled with smoke and dust. All of the workers indicate that the mines were largely unventilated, that drinking water was collected from inside the mines, that they often ate their lunches (with unwashed hands) inside the mines, and that they wore their dirty workclothes home for their spouses to wash with the family laundry. Air and water testing results, when collected, were never reported to the workers and consequently they believed that the workplaces were safe.

For the first time in their lives the workers, who prior to the uranium boom were largely agricultural workers, were earning high wages. The miners were transient in terms of their work histories, working a range of three to 25 different worksites located in the Four Corners area. They worked until the mines closed or their health failed. Many of the miners report that when the company learned that they were ill,

following a health examination, they were fired without notice, severance pay, or sick pay benefits. Also, they were not encouraged to apply for unemployment compensation or workers' compensation. None of the workers were union members. Because the miners were transient, this no doubt led to a diffusion of responsibility among their employers, and the uranium companies may have viewed the temporary workers as expendable in terms of compensatory benefits.

The mill workers I interviewed lived in the Tuba City area and worked in the plant for an average of three years. Unlike the uranium miners, the millworkers were not a transient population but worked primarily at the mill plant. They directly handled unprocessed uranium ore and yellowcake (milled ore) barehanded, and they repeatedly wore the same workclothes, often yellow with yellowcake, until they took them home to be washed. In Tuba City, the millworkers' homes at the site were recently demolished because the foundations had been built with radioactive mill tailings.

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Throughout the interviews, the lack of basic social service benefits and the knowledge of how to gain access to social services was evident. Most of the families interviewed live in rural, often remote areas, without telephones. In addition, they often lack transportation or the financial means to buy gasoline, and thereby must rely on relatives to assist them. One widow, whose husband has been deceased for a year, receives no Social Security. Having no income at all, she was asked how she survives. She said that she depends on her children.

For the families who have received social service benefits, the payment has often been sporadic. The average General Assistance (GA) payment for the four who reported this income was $144 a month, and the average Supplemental Security Income (SSI) payment for the five workers who reported this income was $304 a month. Of the 22 individuals eligible for Social Security, only five workers receive this entitlement, averaging $407 a month. One worker reports he is nervous and stressed because he cannot meet his monthly utility bills. Many others report they have outstanding attorney fees and loan payments.

Many families had not entered claims for unemployment compensation and workers' compensation saying they did not know they were eligible. While some families are dependent on their children for assistance, others rely on spouses' minimum wage employment and are barely able to survive. One

woman explained to me that she eats only enough food to live. Families' resources also become strained when the family takes care of the sick worker in their homes.

Many of the workers had chronic long-term illnesses which required constant care on the part of family members. Illnesses reported by the workers include lung cancer, blood disorders, respiratory illnesses, and birth defects of their children. Many of the workers did not understand their diagnoses and often referred to their illnesses as "chest problems." They were told, in many cases, that the cause of their illnesses was radiation-related. Almost all the workers were unable to return to work or were greatly restricted in the type of work they could do following their diagnoses.

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citizens. Many of the Navajo told me that, if they had known the potential health and environmental risks, they would not have undertaken employment which posed these risks both to themselves and their families.

There is also stress from living in a chronic technological disaster area. One worker, who is suffering from cancer of the mouth and whose wife died of cancer, was relocated by the government three times because his hogan and subsequent two government-built homes were constructed from radioactive materials. A widow lives next to the rubble of her hogan and bread oven which were built of radioactive materials. She wonders if it is safe to have the rubble in her yard. Other people worry about the contamination of their water and air. In general, most of the people worry for their children, themselves, their livestock, and their buildings and land. The stress of living in a potentially unsafe environment is evident among many of the families.

Psychologically, the overall impact of the uranium mining and resulting health and environmental problems upon the Navajo have widespread implications. They view themselves and their world as an interconnected whole. This applies to religion, concepts of health, and how they perceive themselves in relation to the world. Consequently, a disruption in one part of their lives, be it their health or the land, creates an imbalance or disharmony on the overall system. The disruption, then, causes stress not only because of the

immediate problem to the individual but because it threatens the disruption of the Navajo fabric of life and wholeness.

In summary, Mr. Chairman and Committee Members, the government failed to meet its legal and moral obligations to these uranium workers in three ways:

1. The government did not inform the workers of the inherent health risks of uranium mining;

2. The government failed to provide compensation to the workers and their families for the deaths and illnesses of the uranium workers;

3. The ecological damage created by the uranium mining and milling processes was not addressed for an extended period of time thereby creating further health hazards.

The Navajo uranium miners and mill workers are proud people who worked in the nuclear industry for the defense of this country. They worked in good faith, believing that they were not endangered while the government failed in its responsibility to ensure the safety of their work. Providing compensation is the only humane recourse in redressing the wrongs incurred upon these workers and their families.

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Senator BINGAMAN. Thank you very much. Let me ask a few questions, and then I will defer to Senator Domenici to ask his questions of this panel.

First, Dr. Hornung, I tried to follow your testimony as you were going through it. Quite frankly, I didn't get it all. I took it that the basic point you were making was that exposure to radiation, as would occur over this period of time, to people involved in mining of this type, would significantly increase the risk of contracting lung cancer.

Could you summarize it differently for me, or elaborate on that, but give me a summary of the conclusion you reached as a result of your analysis.

Dr. HORNUNG. That is correct. The risk assessment that we did considered also the effects of cigarette smoking. So what we found was that in addition to the lung cancer risk associated with cigarette smoking, there is an independent and very high risk due to radon daughter exposure.

The one point that I was making in the summarization of the testimony was that at the current standard, which is four WLM per year, which most of these miners exceeded during the period of study, and that miner would work for 30 years, which would result in a total accumulation of 120 WLM, that that would result in more than a doubling of the risk of lung cancer, compared to someone not exposed to uranium mining.

Senator BINGAMAN. Thank you. I appreciate that summary. It is more comprehensible to me.

Stewart, let me ask you about the issue of mining versus milling. The bill covers miners; it does not cover anybody involved in milling. I gather that some of the testimony—Dr. Dawson just testified about the problems she encountered in her interviews with regard to people involved in the mill, as well. What is your view as to the proper scope of this legislation?

Mr. UDALL. Well, the group of lawyers that work with me, we had to make some decisions in the beginning, in 1979 and 1980, and there was clearly overwhelming evidence on lung cancer and lung disease. Milling studies had not been done. In fact, they are still underway.

My own views, Senator, because I think this is the—this year, 1990, is the great opportunity, and I think if we can enact this legislation, that Congress is working on right now, let's come back a year or two later, when we have put together a compelling case on milling. That would be my suggestion.

I just don't know enough myself, because we have concentrated on the radiation that got into the bodies of human beings through radon and radon daughters and the other radiation products.

Senator BINGAMAN. Lynda, let me ask you about these nonmalignant lung diseases. Your suggestion is, as I understand it, somewhat different from some of the other witnesses. Your suggestion is that the legislation should provide compensation or should make eligible anybody entitled to compensation as a result of any nonmalignant lung disease that can be traced to the work in the mines, and it would not be limited, in your view, to Navajos or any particular group of miners but to any miners that would make such a claim. Is that correct, or——

Ms. TAYLOR. Yes, Senator. The bill, as it stands right now, is focusing on those nonmalignant diseases, in addition to lung cancer, that are related to radiation exposure in some way. There are some nonmalignant diseases that may not be readily linked to radiation exposure, like silicosis.

Silicoses, emphysema, bronchitis, all of those nonmalignant diseases were, in fact, in Senator Domenici's bill back in 1979, he himself recognizing that some of these diseases were caused by something other than, perhaps, radiation, uranium dust and particles.

My feeling is that the miners, who would otherwise be eligible, Indian and non-Indian, should be able to get compensation for both the lung cancers and the nonmalignant lung diseases.

However, understanding the political realities in Washington, D.C., should it be not practical for us to pursue this effort for all otherwise eligible uranium miners, I do believe that the Navajo, the Indian people, because of the special trust relationship with the U.S. and the responsibility for their health care, this was a particularly vulnerable group because of a past history with tuberculosis, which made them even more sensitive to the effects of uranium mining.

I do believe that, as a political maneuver, if you will, we would need to fall back at least on compensating those nonmalignant diseases that are not clearly associated with radiation for the Indian people, primarily the Navajo.

Senator BINGAMAN. All right, thank you.

Dr. Gottlieb, you did extensive work in running down the extent of the problem here. In your view, what is the condition of medical records for uranium miners? How difficult are the factual determinations that this bill would require a special master to make? Is this something that is readily ascertainable, who would be entitled to compensation under this, or is it a very subjective judgment?

Dr. GOTTLIEB. Yes, Senator, these records are not of the best, I might say. They will require real close scrutiny, and sometimes, if the individuals are still alive, they may have to be repeated. Very few breathing tests were done at that time, and I did many of them in the clinic that I had formed here 10, 11 years ago.

The records, some of them, which were taken at the various Public Health Service hospitals and Indian Health Service hospitals, are incomplete, and they will have to be looked at with a great deal of close scrutiny.

Senator BINGAMAN. Yes, Stewart?

Mr. UDALL. Senator, because it is timely and it fits with comments that you have made earlier, I think it would be very important, and I have told Chairman Haskie this, if this legislation passes, you see, the Public Health Service has good physicians here, but Dr. Gottlieb is a distinguished pulmonary expert, and I think if the Tribe would hire him, if this legislation passes, and let him examine, in effect conduct a clinic, I think this might help, from a medical standpoint, to define who is eligible and who is not, and that kind of extra effort is going to be needed, in my opinion.

Senator BINGAMAN. Thank you very much.

Dr. Dawson, let me just ask, did you limit your interviews and your research to talking with the Navajos who had suffered from

lung cancer, or did you go beyond that to people who had contracted nonmalignant diseases, other types of nonmalignant diseases?

Dr. DAWSON. Senator, to both groups. Essentially, I was looking at those uncompensated workers who had an occupational illness. In terms of how that—of that definition and how it was also perceived by the worker, it became defined to include silicosis and all of the other diseases.

Senator BINGAMAN. Thank you very much. Let me defer to Senator Domenici for his questions.

Senator DOMENICI. Thank you very much, Mr. Chairman. Let me first say to the witnesses and the Navajo people that are here, I am going to be able to stay to complete this panel, and perhaps a little bit of the next panel. I won't be able to stay if the hearing goes on beyond 11:00, because I had already committed before this meeting was set up.

But before I leave, I will tell the Navajo people one more time where I stand on this legislation and what I will do to try to get it passed.

Having said that, let me ask Dr. Hornung now, just quickly, so we will all—Senator Bingaman has tried to clarify your expert testimony, and I think it would be helpful to me if you would just do two things for me.

First of all, do I understand correctly that you are saying that in the population of people, including Navajo people and other miners who would be working in this part of the U.S., there is a certain amount of cancer that will come to them just because a cancer is a disease that we don't know enough about, and a certain number of people would get cancer, but you are convinced, as an expert, that even if we don't have a basic threshold to start with, to measure radiation, as it applies to cancer, you are convinced, as an expert, that, during the period of time that we are studying, there is an exceptionally high risk in cases of cancer among those who are exposed substantially to radiation in uranium mines?

There is a much higher risk than that which average Americans under similar living conditions without radiation would reveal? Is that a true statement?

Dr. HORNUNG. That is correct. Part of the testimony that I gave was that the average miner—this is not including the higher exposed miner. The average miner in our study would, by our estimates, undergo five times the risk that would normally be expected in a population unexposed to uranium mining, and that includes cigarette smoking.

Senator DOMENICI. So then what you are saying—I assume you have reviewed this bill, to some extent, the bill that is before us. I know you have a professional job and you serve in a professional capacity for the U.S., but just generally, not with specificity, do you agree with those who have drafted this bill, that if we include the population, as defined in this bill, in terms of exposure to mining, and the mining conditions of that period of time, that we who are asking the Federal Government for compensation are going to be asking for a reasonable compensation, in terms of not the amount of money but that we are most probably addressing a risk that that exposure is responsible for? As a professional, would that be your opinion?

Dr. HORNUNG. I believe so. As I said, NIOSH has actually recommended that the standard be lowered to one WLM per year.

Senator DOMENICI. I understand.

Dr. HORNUNG. Virtually all the miners in this study exceeded that level. Therefore, I would say that virtually all the miners in this study, and certainly the ones included in the bill, would be, by our estimates, undergoing excess risk of dying of lung cancer.

Senator DOMENICI. So just basically, if Senator Bingaman and I hear objections to this, on the basis that cancer is a serious ailment among our population, "You don't have any real proof that there is a direct relationship here," your testimony today will say the standard we are using will indeed encompass an unreasonably risked population with radiation that might indeed have yielded cancer; is that correct?

Dr. HORNUNG. I would say that is—I am in perfect agreement with that, yes.

Senator DOMENICI. Secretary Udall, could I ask you a question about mining. In your research for your cases, did you dispel any notion that if the Atomic Energy Commission of the U.S. throughout the period of 1941 through 1971, or 1947 through 1971, had insisted upon a much lower level of radiation for miners, is there any doubt in your mind that the mining industry of the U.S. could have supplied that cleaner environment, technologically?

Mr. UDALL. I have no question on that, Senator. One of the most interesting things that came out, with regard to the mining companies, because the Federal Government, both the Public Health and AEC officials, never really put the pressure on them and told them what they had to do.

But the most interesting example, Anaconda, or is it Kennicott, that came over to the Reservation, they were a copper mining company in Montana; they brought their ventilation experts down, and they almost eliminated—they did a fantastic job. So the mining industry could have done the job if they had been given a push.

I want to add one point, though, to clarify what you were inquiring about just a moment ago.

Senator, those early mines on the Navajo Reservation, some of those early miners, in one month, in one month, I can show you files, inhaled more radiation than a miner today, under the regulations they are proposing, would get in 20 years, and most of those miners are dead. Their relatives and their widows are here today. That's what we are talking about.

Senator DOMENICI. Whichever of the experts knows this, and this is my last question; it is my understanding that even though the state of the art with reference to risk assessment and radiation and cancer is still evolving, that clearly the case study of this particular situation, the exposure to high levels of radiation by uranium miners, including Navajo Indian miners, is indeed one of the most significant sources of evidence regarding exposure to radiation that we have in our inventory of evidence as we attempt to make risk assessment in this area. Is that true? Do you know that, Doctor, or perhaps you do, Dr. Gottlieb.

Dr. HORNUNG. That is certainly true. In my experience with NIOSH, 18 years with NIOSH, the uranium miners in the Colorado

Plateau have undergone the highest incidence of lung cancer of any occupational group we have studied.

Senator DOMENICI. And, Doctor, it is also clear now that the new rules with reference to ventilation and exposure to radiation that have been established by various health-related agencies of the U.S. Government can be accomplished by the mining industry and dramatically reduce the risk, as you understand it, as a health officer, of contacting cancer from exposure. Is that correct?

Dr. HORNUNG. Yes, our recommendation included technical feasibility of ventilation, being able to reduce levels in the mines down to a level which would result in one WLM per year.

Senator DOMENICI. Thank you very much.

Senator BINGAMAN. Thank you. Before I dismiss this panel, let me make one additional announcement here. I am informed that in addition to Secretary Udall, as counsel in the litigation which brought this issue to the floor, he had three other counsel who are here today, and they are Ambassador Bill Mahoney, who is here and was referred to earlier, and Tom Udall and Albert Hale. If those three would please stand and be recognized. We appreciate their presence here today very much.

All right, with that, we will dismiss this panel and call the second panel. We have five witnesses on the second panel, Mr. Phillip Harrison, Mr. Raymond Joe, Mr. Earl Mettler, Ms. Pearl Nakai and Mr. Charles Roybal. If they would all come forward, please.

[Brief recess.]

Senator BINGAMAN. All right, we will go ahead with the testimony from this second panel, and we will take this the same way we did with the testimony from the first panel. We would like each of the witnesses to testify, or all of them to testify, and then we will have some questions at that point. Let's start and just go down the table here.

Mr. Phillip Harrison is the president of the Uranium Radiation Victims Committee here in Shiprock. We are very pleased to have you testify today.

Let me just, once again, suggest the same thing to this panel that I suggested to the previous panel, and that is, if you could summarize the main points you want to make, we will include your entire written statement in the record. But if you could take three to five minutes each and summarize it, that would be very helpful to us.

Mr. Harrison, go right ahead.

STATEMENT OF PHILLIP HARRISON, JR., PRESIDENT, URANIUM RADIATION VICTIMS COMMITTEE

Mr. HARRISON. Thank you, Senator Bingaman and Senator Domenici and the rest of the panel that were up here previously.

Good morning, Mr. Chairman, Committee members, my name is Phillip Harrison, Jr. I am a surviving dependent and a former uranium miner. I am also the president of the Uranium Radiation Victims Committee, representing Red Valley and Cove Chapters and former Navajo uranium miners, widows and dependents.

In my 7 years of dedicated services to the Committee, I have witnessed and experienced the tragedy and the ordeal my people have

suffered. Due to this, I am here today to testify on behalf of the deceased miners, former miners, widows, dependents and also the many numbers of mill workers along with their families who are excluded from the uranium compensation issues.

It is an honor to be asked to testify on the impact of the past uranium mining activities and in support of Radiation Exposure Compensation Act. Therefore, I will share with you some background information.

During the years of 1940s through 1970s our fathers have worked mining uranium in the Colorado Plateau. The community of Red Valley and surrounding areas was a mining activity boom town where millions of tons of uranium were removed. The introduction of the American industrialized system emerged on the Navajo Reservation and many were lured by the uranium companies without hesitation

The need for economic survival had prompted many men to work the unsafe mines. The miners were intentionally never told about the hazards of uranium mining and were excessively exposed to low-level ionizing radiation. The name of the game was production and greed and not the welfare of the Nation.

Safety measures, proper ventilation and human lives were ignored. The mine conditions were dogholes, and the workers were encompassed with radon, a radioactive gas that was so intense that it is hard to imagine the penetrating effects to continuous exceeded limit contact.

It was due to these conditions many have contracted lung cancer and pulmonary diseases. The bill pertains only to the specific diseases. It should include all radiation-related diseases. After all, radon did not ignore Indians or the mill workers. The Atomic Energy Commission knew about the hazards but did nothing to protect the workers because of the money uranium brought in.

Through the years, Navajo miners were guinea pigs for the Public Health Service and the Bureau of Mines. Mr. Chairman, the companies and the Atomic Energy Commission's sheer negligence was uncalled for, and the recognition for the Native American miners is long overdue.

The livelihood of the Native American family togetherness has been destroyed and devastated from the uranium poisoning. As the Ninth Circuit Court stated, "We agree with the District Court that this is the type of case that cries out for redress, but the courts are not able to give it; Congress is the appropriate source in their instance."

We have every faith in our leaders, tribal, state and nationally, that the HR 2372 will be passed unanimously. After many years of frustration, hardships, pain and suffering, we are entitled to be recognized and compensated for our losses. The compensation cannot replace our loved ones but will relieve and remedy our burdens. But our work cannot cease. We have yet to address our land, water, livestock and food cycles that are contaminated.

We also have our children that are genetically affected from the impact of uranium mining and spouses that are suffering from the same symptoms as their husbands. We also share our sympathy with the Utah downwinders, atomic veterans, mill workers and all the radiation victims worldwide.

In conclusion, I would like to thank all the people that contributed, advocated and supported this Bill. Our prayers will continue, despite all the obstacles and setbacks. Thank you.

[The prepared statement of Mr. Harrison follows:]

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STATEMENT OF PHILLIP HARRISON, JR.

TO THE SENATE LABOR COMMITTEE

ON THE RADIATION EXPOSURE COMPENSATION ACT

Good morning Mr. Chairman and Committee Members:

My name is Phillip Harrison, Jr. I am a surviving dependent and a former uranium miner. I am also the President of the Uranium Radiation Victim's Committee representing Red Valley and Cove Chapters and former Navajo Uranium miners, widows and dependents.

In my seven (7) years of dedicated services to the Committee I have witness and experienced the tragedy and the ordeal my people have vainly suffered. Due to this, I am here today to testify on behalf of the deceased miners, former miners, widows, dependents and also the many numbers of mill workers along with their families who are excluded from the uranium compensation issues.

It is an honor to be asked to testify on the impact of past uranium mining activities and in support of Radiation Exposure Compensation Act. Therefore, I will share with you some background information.

During the years of 1940's through 1970's our fathers worked and mined uranium in the Colorado Plateau. The community of Red Valley and the surrounding areas was a mining activity boom town where millions of tons of uranium were removed. The introduction of the American Industrialized system emerged on the Navajo Reservation and many were lured by the uranium companies without hesitation. The need for economic survival

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had prompted many men to work the unsafe mines. The miners were intentionally never told about the hazards of uranium mining and were excessively exposed to low-level ionizing radiation. The name of the game was production and greed not the welfare of the Nation. Safety measures, proper ventilation and human lives were ignored. The mine conditions were "dogholes" and the workers were encompassed with radon, a radioactive gas that was so intense that it is hard to imagine the penetrating effects to continuous exceeded limit contacted.

It was due to these conditions many have contracted lung cancer and pulmonary diseases. The Bill pertains only to the specific diseases it should include all radiation related diseases after all radon did not ignore Indians or the mill workers. The Atomic Energy Commission knew about the hazards, but did nothing to protect the workers because of the money uranium brought in. Through the years Navajo Miners were "guinea pigs" for the Public Health Service and the Bureau of Mines. Mr. Chairman, the companies and the Atomic Energy Commission's sheer negligence was uncalled for and the recognition for the Native American miners is long overdue.

The livelihood of the Native American family togetherness has been destroyed and devastated from the uranium poisoning. As the Ninth Circuit stated: "We agree with the District Court that this is the type of case that cries out for redress, but the courts are not able to give it: Congress is the appropriate source in their instance".

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We also have our children that are genetically affected from the impact of uranium mining and spouses that are suffering from the same symptoms as their husbands. We also share our sympathy with the Utah Downwinders, Atomic Veterans, Mill Workers and all the radiation victims worldwide.

In conclusion, I like to thank all the people that contributed, advocated and supported this Bill. Our prayers will continue despite of all the obstacles and setbacks.

Thank-you.

Phillip Harrison, Jr.
P. O. Box 1526
Shiprock, New Mexico 87420

Senator BINGAMAN. Thank you very much for the testimony.

Our next witness is Mr. Raymond Joe, who is a Navajo miner who lives here in Shiprock. And Mr. Joe's testimony, as I understand, will be translated by Perry Charley. Please go right ahead, Mr. Joe.

STATEMENT OF RAYMOND JOE, SHIPROCK, NM

Mr. JOE. Good morning, Senator.

[General applause.]

The INTERPRETER. For the record, my name is Perry Charley. I am with the Federal Office of Surface Mining with the Navajo Abandoned Mine Lands Reclamation Department.

[Statement given in Navajo language and translated into English.]

Mr. JOE. My name is Raymond Joe, and I am a miner from Cove, Arizona. I am not educated. I am not conversant in the English language, but I will give a portion of my testimony as I remember it.

I worked in many different uranium mines in the states of Colorado and Utah. I started in Cove, Arizona, in 1952, for Kerr McGee Mining Corporation. I worked a total of 15 years in these mines. Now I am afflicted with a severe health disease and lung cancer.

When we first started working in these mines, we were never informed of the dangers that were involved with radioactivity. We were never informed of the dangers that were involved in uranium mining. We were just required to work. I am now scarred. I am emotionally scarred and I am physically scarred. I sit here before you with just one lung. So I know now that uranium is dangerous.

In November of 1989, I went to Washington, D.C. At that time, I recall that of all the miners I have worked with, there were only three left. Since my return from Washington, D.C., to testify in front of the Subcommittee on Administrative Law, one other miner has died. So there are only two of us left. And this is how I know it is dangerous.

Uranium is in my body. It is in my lungs. I have problems getting up in the morning; I have problems with my breathing. I am severely short of breath. Yes, I go in to see the hospital physicians, but at best they tell me just to take care of myself, and the only thing they have for my pain is this medication.

We sit here before you requesting compensatory relief. Please listen to our pleas, Senators. It was the government's fault that we were not told of the dangers involved in uranium radiation. They were in the wrong. We were just told to work. We were never told of the dangers. All we want is monetary relief while we still live here today. This is how I feel.

My kids, because of my health problems, never went beyond a formal education. They have no college education. I would have liked to have seen them go on. I live in substandard housing that I built myself, despite my health problems. I built this in 1972. I used to have running water, but because of my health problem and because of my financial status, I no longer have these facilities.

So I thank you for this time, Mr. Senators. I ask that you will consider our pleas again, and I trust that my statement will be moving and you will be listening to our pleas. Thank you.

[General applause.]

Senator BINGAMAN. Thank you very much.

We will have some questions of each witness, but first let's complete the testimony.

Our next witness will be Ms. Pearl Nakai, from Red Valley, Arizona. She is the widow of a uranium miner. She has testified previously before Congressional committees, and if she would go ahead and give her testimony, and then again, Perry Charley will translate the testimony.

STATEMENT OF PEARL NAKAI, RED VALLEY, AZ

Ms. NAKAI. Good morning, Chairman and Senator Domenici and all the Committee members. For coming out here to visit us, to hear our testimony, I thank you very much.

[Statement given in Navajo language and translated into English.]

[General applause.]

Ms. NAKAI. My name is Pearl Nakai, and I am a widow from Red Valley, Arizona. My people who are here today, I thank you for your response to our public meeting here. What the purpose that we are here for is not for a happy occasion but rather to share our plights, to share our griefs with you.

My spouse has been deceased now for 15 years. He started working in the uranium mines in 1949, and he died in 1974. I am now alone with my kids. We have nobody else to look to. I remember when my husband used to work in the mines, I used to travel with him. The reason why we did that was because of the lack of employment on the Navajo Reservation. That was our only source of employment. We had to provide for our kids. And through these journeys, I know we used to live in small, substandard, one-room houses.

I remember when my husband came back down from the mines, he used to be covered with dust that he got while working in the mines. He usually would hang his clothes in the windows, right behind our bed, and all the dust would fall down into our food and into our water and into a lot of things that we used to use there.

We never knew that the dust that he was covered with, the dust that hung onto his clothes, was dangerous, but now we know. It is hard to be alone with my kids. My kids, because of the health problems and the death of their father, could not continue their education.

I appeal to you, Senators; I say it is hard. We need your assistance. We live in small houses; we have no water; we have no electricity. We have nobody to haul wood for us, because our husbands are deceased. I am not the only widow here. There are countless widows out there. They face the problems, and because of these, we blame the U.S. Government.

We blame them for a lot of the wrongs that they did, for them refusing to tell us that what we encountered in the uranium mines was dangerous. So we ask you, we ask that we be compensated; we

ask that we receive monetary relief; we ask that you respond to our pleas.

You heard Mr. Raymond Joe here. He is afflicted with lung disease. I know for a fact that it not only gets into the lungs; it gets into the stomach and a lot of our major organs. I have seen this happen before. I have seen it happen in my own family.

Again, we blame the U.S. Government. We were exposed to radioactive dust. Our husbands drank the waters that were seeping in the mines. They ate their lunches in the mines. We were exposed to radioactivity. So we know right now that it is dangerous. If my husband was alive, we wouldn't be suffering; I wouldn't be sitting in front of you crying.

So I ask you, please help us. We traveled to Washington, D.C., on several occasions. Now we are here again. We ask that you continue your support. We ask that you extend your support. We ask that you back up the Radiation Compensation Act. This is the extent of my presentation here.

When I go out on the field, I look at a lot of the mines out in Cove and Red Valley, in Oak Springs, and all we see is holes. These are just reminders, and it is hard.

So we ask you, we ask you that these things be considered. We ask that you continue the support that you have given us. I thank you, and I thank my people. And that is the extent of my testimony. Thank you.

Senator BINGAMAN. Thank you very much. Thank you, and we will have some questions, once we hear from the other two witnesses.

Our next witness will be Mr. Earl Mettler, who is with Mettler & LeCuyer in Albuquerque. It is a firm that has been involved very extensively in workmen's compensation issues related to injured miners. We are very pleased to have you here, Earl. Go ahead with your testimony.

STATEMENT OF EARL METTLER, ESQUIRE, METTLER & LECUYER, P.C.

Mr. METTLER. Thank you, Mr. Chairman. I just want to address mainly one technical point relating to this Bill, which is whether workers' compensation is an alternative remedy.

I have had an office in Shiprock in my private practice for about seven years and had learned early on when I came to this community about the situation of the uranium miners and their families. And we have done whatever can be done by way of representation and public assistance or workers' compensation claims, and not much can be done.

The contingent of Navajo miners that we have represented are mainly from the Red Valley and Cove area. They followed the work to Colorado and Utah, primarily, and so we try to do what we can under the laws of three or four states. Actually, four states.

And it is my feeling, from what I hear from my clients, that the Navajo miners were particularly victimized by the conditions of the mines. I think they were less able to question or complain about the conditions in which they worked, even if there was some information that there might have been a health problem.

Regarding whether workers' compensation provides a remedy, it really doesn't. The success rate of workers' compensation claims is very low, and for those few claims that are successful, the amount received is extremely low. The problems that we have encountered with those claims are very short statutes of limitations or notice requirements.

I have people come in every few months who had no idea that they might have such a claim, and now it is too late to file. We are unable to locate last employers, which is often the starting point for a claim, or the last employer—or it is unclear where the work was, even what state it was in, or the last employer is no longer in existence; it is a company that has dissolved. There may be no records of insurance coverage, and so there is no one to name as a respondent in a claim.

In Colorado claims, when you recover benefits, there is an offset for Social Security that is being received. So often the payment rate is very low. There are proof requirements that are unrealistic, such as, in New Mexico, State law says that you can only recover for an occupational disease if you incur that disease within 10 years of when you last worked.

And I note that the Justice Department complains about this proposed bill that it doesn't conclude the short latency periods. They say, "Well, the latency period is up to 20 years, not one year; so the rapidly occurring cancer should be excluded from the bill."

Well, the State of New Mexico says if you are 20 years until diagnosis, that's too long, and they won't compensate you. They say that it has got to occur within 10 years from when you last worked, and we know, scientifically, that that's not valid, but that's what the law says.

Finally, if you can clear all these hurdles, the problem is that the compensation itself is based on the wage rate, and the wage rates that these men worked under were extremely low.

So, for example, the last workers' compensation case that I finished was a man who worked in this area and then up in Colorado for a few years in the sixties. He died of cancer in 1982. His wife came into our office in 1985, and we would have been too late in most states, but in Colorado, she could still file. The claim was successful. We showed his cancer was work related.

Compensation was awarded at the rate of $70 a week, and with the Social Security offset for the Social Security the family was getting, the net compensation rate was $28 a week. At the same time, I did another hearing for another widow, and she ended up with $21 a week, and that was a radiation fibrosis case. But these were cases of death that were clearly work related, and that's all people are getting.

So workers' compensation is an inadequate remedy. If anyone thinks it is adequate for some people, it would be a simple matter to allow an offset in the Bill for what people get in workers' comp, but it is almost meaningless, because they get almost nothing.

So, in conclusion, I think the plight of the Navajo miners is particularly compelling, and this Bill is clearly necessary. It is well within the authority of Congress to provide this type of remedy, and I commend you, Senators, for your support of this Bill. Thank you.

[The prepared statement of Mr. Mettler follows:]

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Earl Mettler
Stephen T. LeCuyer

March 12, 1990

Hon. Jeff Bingaman
Senate Energy Committee
Washington, D.C. 20001

Re: Compensation of Uranium Miners

Dear Sen. Bingaman:

The following comments are offered on the bill recently reported out of the Senate Labor Committee, which relates to relief for nuclear test fallout victims and uranium miners. I wish to address particularly the portions of the bill relating to uranium miners. Further, since the medical and other grounds which support compensation for the uranium miners are well known to you and will be addressed by other commentators, I would like to specifically address the comments of the Department of Justice (DOJ), as contained in its letter of February 27, 1990 from Bruce C. Navarro to Sen. Biden.

Overview

The DOJ comments attempt to recast the Federal Tort Claims Act as, in effect, a limitation on Congressional power, and exaggerate the notion that its exception and limitations reflect unalterable public policy. On the contrary, the Act and the exceptions stated therein merely reflect a portion of "the boundary between Congress' willingness to impose tort liability upon the United States and its desire to protect certain governmental activities from exposure to suit by private individuals." United States v. Varig Airlines, 467 U.S. 797, 808 (1984). Where the governmental activity is deemed, as a matter of federal policy, to be one for which compensation is appropriate, the technical proscriptions of the Tort Claims Act do not limit or otherwise inform the Congressional determination that a remedy should be provided.

The Act's exemption for discretionary functions of the Government, which was the basis for decision of the courts to deny compensation to the uranium miners, was intended to prevent judicial intervention in political, social and economic judgments of regulatory agencies. Varig Airlines, supra, at 820. With respect to the uranium miners, the judgments have were made long ago, and the entire sphere of activity is historical, rather than ongoing. Further, the judgments made are now seen to have had a

devastating impact upon a discrete group of people. The policies in favor of compensation greatly outweigh any need to continue to protect the decision-making process.

The specific contentions of DOJ intermingle and confuse the two unrelated parts of the bill. Justice takes the position that the uranium miners have an alternative remedy and that the downwinders cannot prove causation. It then mixes these two positions, to leave the impression that the miners also cannot prove causation and the downwinders also have another remedy.

In fact, the miners' supposed alternative remedy is an illusion, as explained below. And, medical and legal information shows clearly that any attempt to question the causation of lung disease by uranium mining is completely unfounded.

Causation: The Federal Role

Although the Justice Department states that the bill would provide a remedy without regard to whether the illnesses were "caused by actions of the United States," the role of the federal government in bringing about the illnesses and deaths of uranium miners is well documented. The federal government was aware of the harmful effects of radiation exposure and the uranium miners, not only from scientific information, but from a first-hand study of miners. Nevertheless, the government promulgated no federal standard for acceptable levels of radiation exposure until 1967. Further, the government made a deliberate decision not to warn the Navajo miners it was studying that they were at risk, even though it knew as early as 1959, from the results of the study, that illness and death were likely to result. Begay v. United States, 768 F.2d 1059 (9th Cir. 1985).

The role of the federal government in causing these illnesses and deaths prompted both the trial and appellate courts hearing the Begay case to note that the case "cries out for redress" by Congress. Begay, 768 F.2d at 1066, and Begay v. United States, 591 F.Supp. 991 (D.Ariz. 1984).

Justice attempts to minimize the federal responsibility by stating that "only a portion" of the uranium mined between 1947 and 1971 was purchased by the government. This completely ignores the facts that the Government (1) purchased all uranium for most of that period, (2) effectively controlled the rate of production for all of that period, (3) aggressively encouraged production for many years, and (4) did not implement safety standards for the mines until the very end of that period.

DOJ complains that no "legal theory of liability" would be required. But the legal theories of liability are clear from the Begay decisions. The government only escaped liability in those cases because of an exception in the Federal Tort Claims Act, the exception for discretionary functions. Understandably Justice would like to require claimants to fish about for legal theories in every claim, so that it could use its arsenal of legal defenses. The bill takes a wiser approach, however, and avoids the requirement that each claim present over again the evidence the courts in the Begay cases acknowledged was already so persuasive that it "cries out for redress."

Likewise, in discussing the Federal Tort Claims Act, DOJ says there is "less-than-compelling evidence to support change," and so the "traditional FTCA regime" should apply. But the bill does not amend the FTCA. There is no reason to require a showing a general defect in the FTCA, because no general change would be worked by the bill. The effect of the bill would only be to remove the availability of an exception to the FTCA in this one very narrow, specific and compelling category of case.

DOJ uses the buzzword "entitlement program" to label this bill. The bill does not, however, propose any permanent or ongoing payments to individuals; only a one-time compensatory payment is allotted. Further, the uranium miners must show a specified level of exposure during their work underground. Once that amount of exposure is shown, causation is sufficiently clear that a presumption comes into play. Thus, the payments proposed by the bill are in fact based upon causation, and are not accurately described as an entitlement program.

Causation: The Medical Evidence

The bulk of the statement of the Justice Department deals with the medical causation issue as it applies to the downwinders. Yet, it attempts to apply the disputed medical issues relating to their exposure to the uranium miners also, by saying in passing that "scientific evidence does not support the conclusion that many cancers have been caused through the government's...activities with regard to uranium miners." Statement of Mr. Navarro, p. 2.

On the contrary, there is no doubt that uranium mining caused miners to die of cancer. The district court in Begay found as follows:

> The weight of the evidence, including medical testimony, statistical data and historical events, leaves no doubt that there

> is a direct relationship between the high levels of radiation exposure suffered by the underground uranium miners and their excessive incidence of respiratory tract and lung cancer.

Begay, 768 F.2d 1059, at 1065. The medical studies through the years have been quite numerous and quite definite in showing a statistically significantly higher incidence of lung cancer among uranium miners, such that there is no longer any medical debate about this basic fact. See for example, Archer, et al., Respiratory Disease Mortality among Uranium Miners, Annals of N.Y. Academy of Sciences, vol. 271, pp. 280-293; Archer, et al., Frequency of Different Histologic Types of Bronchogenic Carcinoma as related to Radiation Exposure, Cancer, vol. 34, pp. 2055-2060; and International Conference on Radiation Hazards in Mining, 1981, pub. by American Institute of Mining, Metallurgical and Petroleum Engineers, Inc.

If the thrust of the Justice Department's assertion that evidence does not show that "many cancers" have been caused by mining is that not many different kinds of cancers are caused by mining, then the statement is not important. The bill is much needed even if only one type of cancer is caused by mining.

If the thrust of the comment is that there are not very many cases of cancer caused by mining, the same comment applies. The medical/epidemiological studies I have seen generally report on a total uranium miner population of slightly over 4000 miners, and estimate that there will be up to about 600 cases of cancer attributable to mining within that population. While this is not a large number of cases compared to the numbers covered by other government programs, that does not diminish the rightness of providing for those victims.

DOJ states that the bill does not require that "causation be demonstrated." Justice neglects to mention that there is a threshold requirement of total radiation exposure specified in the bill in order for a miner to recover. Thus, all the bill does is impose a presumption, a procedure well known in the law, so that the same epidemiological evidence does not need to be presented in every case. This is much different from dispensing with all causation requirements, which is what DOJ implies the bill does.

Worker's Compensation

The Justice statement repeatedly cites the availability of worker's compensation as a remedy that removes the need for the bill. In fact, worker's compensation is not an effective alternative remedy.

The hurdles to recovery under worker's compensation are many and, for most miners, insurmountable. These include the unrealistic time limits on filing, the fact that there is often no one to file against because the last employer cannot be found by the time the cancer develops, and state statutes that impose impossible burdens of proof. Most importantly, any compensation received in worker's compensation claims is based upon wage levels when the work was done. This provides a benefit level that is extremely low by the time the cancer manifests itself, making it barely worthwhile to pursue a claim.

In my own practice, I have placed these claims in a special category because of the tragedy of the uranium miners, and have used different standards to decide whether to file a particular case than I use for other worker's compensation cases. If strict practicality governed, I would have filed almost no worker's compensation claims for miners or their widows, because there is so seldom a recovery.

By way of additional examples, the worker's compensation law of New Mexico contains the following provisions:

(1) A claim may not be filed unless written notice has been given to the employer within 30 days of the onset of illness. Although I have represented about 20 Navajo miners or widows in cancer cases, I have only seen one case where the family contacted an attorney fast enough to meet this requirement, and in that case it depends upon an interpretation of the law that would let the time run from death rather than onset.

(2) A claim must be filed within one year of onset. I have had to tell a number of widows who missed this requirement that worker's compensation was unavailable to them because of it.

(3) There can be no recovery for a cancer which develops more than 10 years after the miner last worked. As the Justice Department points out, there is a much longer latency period medically known to be present with these cancers.

I have evaluated approximately 60 cases of respiratory illness in uranium miners. About 30 of these cases simply could not be filed under worker's compensation laws. Of the 30 that could be filed, we have seen a favorable decision on about 15, most of them cancer cases.

In those cases in which a favorable decision was entered, there has been no monetary recovery in several cases. This is because the decisions were entered under Colorado law, which allows the last employer an offset for any Social Security benefits the worker or his family receives. The low wage rate when the mining was done causes a low worker's compensation benefit rate. The Social Security benefits, even though they also are quite low, are still enough to wipe out the worker's compensation.

Two recent cases I handled went remarkably well. The claims were timely filed, the last employers could be identified, they had insurance, and the medical link between cancer and mining is so well established that it was not argued. Favorable decisions for two widows and their families were entered. One widow will receive nothing because the Social Security offset completely wipes out the obligation of the employer to pay anything. The second will receive less than $100.00 per month.

Thus, whether viewed in terms of the number of cases that are successful or the level of compensation received, worker's compensation does not provide an adequate remedy.

Other comments

The Justice Department states that "similarly situated" persons would not be helped by the bill, and that the bill would treat affected persons differently from "legally and factually similar claims." It does not specify who has similar claims, and whether those persons can or cannot recover under the FTCA, and why or why not. The claims of the miners, as discussed in Begay, seem quite unique.

In connection with that position, Justice also complains that "significant numbers of uncompensated injuries" have not occurred. Even if the number of miners helped by the bill is relatively small, this does not seem a legitimate reason to refuse such help.

Conclusion

The DOJ statement is not soundly based upon either legal principles or medical information relating to the uranium miners. Instead, it garbles the issues and primarily presents only policy concerns that are the responsibility of Congress, not the executive branch, to resolve.

The causal connection between the Government's activities related to uranium mining and the illnesses now suffered by the miners is completely clear. The reasons for allowing some measure of reasonable compensation are compelling.

Yours truly,

Earl Mettler

EM:cs

Senator BINGAMAN. Thank you very much for your testimony. Our final witness is Mr. Charles Roybal, who is the Executive Director of the New Mexico Mining Association, and he is here representing the Mining Association, as well as the American Mining Congress. He is also formerly Secretary of the Department of Energy and Minerals.

We are very pleased to have you here, Charles. Go right ahead with your testimony.

STATEMENT OF CHARLES E. ROYBAL, EXECUTIVE DIRECTOR, NEW MEXICO MINING ASSOCIATION, ON BEHALF OF THE AMERICAN MINING CONGRESS

Mr. ROYBAL. Thank you, Senator. Thank you, Senator Domenici also for the opportunity to be here on behalf of the New Mexico Mining Association and the American Mining Congress.

The American Mining Congress especially has been extensively involved in health and safety issues affecting underground miners, and my testimony will address the fact that in conjunction with miners and relevant government agencies, the mining industry has worked diligently to reduce the potential health risks to underground uranium miners.

Mr. Chairman, it is, I think, especially appropriate for me to be here at this hearing to do a couple of things. One is to support very strongly on behalf of the New Mexico Mining Association the Compensation Act, and also, perhaps, to tell you about the commitment of our industry to provide a safer working place, that we have learned, over the course of years, the lessons of history.

Some of the things that have been done, very briefly—and I will summarize greatly my testimony—is that we have learned a few safety measures that we think greatly reduce the risks to miners. Ventilation management practices have dramatically reduced exposure levels that cause cancer.

Secondly, detailed training programs for those working underground allow those individuals to recognize when they may be at risk and how to protect themselves. This has led to dramatic improvements in exposure levels. In addition to ventilation management, there is a whole series of technologies which may be appropriate, given mining situations, which have been explored, and they include sealants, filters, different pressurization devices. And we hope that these devices can, again, reduce the risks to miners.

Mr. Chairman, the uranium industry, as you are well aware, has experienced a great economic downturn. Today there are fewer than 2,000 uranium miners in the country, down from about 22,000. This is due largely to the fact that uranium, or yellowcake, used to sell for $43 a pound. The price is now more like $9 a pound. And production in the country has fallen from about 43 million pounds in 1980 to about 12 million pounds today.

To summarize, the industry, the Bureau of Mines, MSHA, have worked together over the last 20 years to minimize miners' exposure to radon daughters. In our view, these efforts have succeeded admirably. We know that the past years and histories have been tragic. That's why we are here today, Mr. Chairman, Senators, to support this bill. Thank you.

[The prepared statement of Mr. Roybal follows:]

TESTIMONY OF NEW MEXICO MINING ASSOCIATION AND AMERICAN MINING CONGRESS

I. INTRODUCTION

My name is Charles E. Roybal. I am Executive Director of the New Mexico Mining Association. I am testifying today on behalf of that Association and the American Mining Congress, a national trade association that has been extensively involved in health and safety issues affecting underground uranium mines. My testimony will address the fact that in conjunction with the miners and relevant government agencies, the mining industry has worked diligently to reduce the potential health risk to underground uranium miners. These efforts have produced controls that have demonstrably reduced miner exposure to radon daughters in underground uranium mines.

II. RADON DAUGHTER CONTROLS

Since 1968 detailed ventilation management practices in underground uranium mines have been implemented to maintain compliance with radon daughter exposure limits. Experience has demonstrated that a properly designed mine ventilation program represents the best available technology to protect miners in underground uranium mines from exposure to radon daughters. A ventilation management program involves consideration of many factors, including such things as mine size, drift size, number and size of fans, air restraints (such as bulkheads, stoppings,

brattices and curtains), bore holes, secondary ventilation systems, back filling and the use of inactive workings as ventilation passageways.

The training of underground personnel to recognize the hazards and the use of these controls for their protection is probably the most important factor in controlling individual exposures. A ventilation management program is a complex and dynamic system that is tailored to assure compliance with occupational protection requirements and to optimize the mining method utilized.

Other methods of radon control (such as overpressurization, blasting at the end of shifts, retreat mining towards intake air, minimizing the number of ore faces exposed, sealants, filters, etc.) have been evaluated by industry, the U.S. Bureau of Mines, and MSHA. All of the methods of ventilation and radiation control examined are, depending on site-specific circumstances, currently utilized to the maximum extent practicable where they have been proven to be useful and technically and economically feasible.

In addition to the use of the best available controls to keep miners' exposure to as low as reasonably achievable levels, economic conditions in the uranium industry have

resulted in reduced miner exposures. Since 1980 every important index of the economic status of the domestic uranium industry (including price, production, employment, exploration and capital expenditures) has declined sharply. For example, in June, 1978, the price for yellow cake was about $43.00/pound compared to a current spot market price of approximately $9.00/pound. U.S. production in 1980 was 43 million pounds compared to current production of about 12 million pounds. In 1979 total employment in the uranium industry was 22,000, today it is less than 2,000. More than a billion dollars has been written off by the uranium industry since 1980.

III. THE RISK FROM RADON DAUGHTER EXPOSURE IN UNDERGROUND URANIUM MINES

Radiation risks have been assessed and reassessed over a period of many years by expert national and international radiation health organizations such as National Council on Radiation Protection and Measurements (NCRP), International Commission on Radiological Protection (ICRP), United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and others so there is much valuable expert analysis. More evidence exists in the form of extensive epidemiological studies with respect to human exposure to radiation in general, and radon daughters in particular, than virtually any other potential carcinogen.

The potential risk to underground uranium miners under current exposure conditions can be distinguished from the conditions in the mines upon which most of the miner epidemiological studies are based. The miners in those studies were exposed to radon daughter concentrations that were orders of magnitude higher than today's miners and many were smokers (e.g., 80% in the USPHS study were smokers). The best and most relevant epidemiological study is the Public Health Service's U.S. uranium miner study, because of the size of the groups of miners, duration of follow up and availability of data, including smoking histories. This study indicates no statistically significant excess lung cancers below about 100-120 Working Level Months (WLM) cumulative lifetime exposure and no excess lung cancer in nonsmokers below about 465 WLM. Since 1972 uranium miner exposure has been limited to no more than 4 WLM per year with an assumed working life time of 30 years -- i.e.; a maximum potential cumulative exposure of 120 WLM. However, the radon exposure controls implemented to assure compliance with the 4 WLM annual standard have reduced average miner radiation exposures in underground uranium mines well below that limit.

Several multi-year studies have established that about 93% of all underground uranium miners are exposed to less than 2 WLM per year. In a given year, only 6% of the underground uranium miners have radon daughter exposures of 2-3 WLM per

year, only about 1% have exposures above the current 4 WLM standard -- this, of course, means that in many years no miners have exposures over 4 WLM. For 1985 the Mine Safety and Health Administration (MSHA) estimated that the average exposure to radon daughters in currently operating underground mines (all but two were uranium mines) was 1.22 WLM per year. Additionally, it is clear that no miner will be exposed to anything approaching 4 WLM every year for an assumed thirty year working lifetime. This is because the varying annual exposures of any individual miner tend to average out over a period of years, and the average miner works considerably less than 10 years in underground uranium mines.

A comprehensive study of U.S. underground uranium miners' exposure since the inception of record keeping (1968-1985) involving some 17,947 miners indicates that:

1. The average working period of underground uranium miners is 3.2 years with a range of from less than one year to 18 years.

2. From 1972 when the current 4 WLM standard became effective, records for about 15,793 miners indicate an annual average exposure of 1.1 WLM and an average cumulative exposure of 3.5 WLM with a range for cumulative exposures of from 0.01 WLM to 43 WLM.

Thus, as I noted previously the controls necessary to meet the post-1972 4 WLM per year regulatory limit has reduced the potential risk to uranium miners from radon daughter exposure to acceptable levels. One recognized method for evaluating the significance of the risk to miners from radon daughter exposures is to compare it with the risk to the general public from normal background radon daughter exposures and other occupational risks. The average cumulative exposure of persons in the United States from natural background to radon daughters is comparable to the average cumulative exposure of underground uranium miners. Thus assuming a hypothetical risk to an average miner exposed to about 10 WLM (1 WLM/yr x 10 yr), an average homeowner (exposed to about 0.2 WLM/yr x 75 yr = 15 WLM) would be exposed to the same potential risk and in neither case would this risk be considered significant. Additionally, some members of the general public (about 1% of the U.S. population, or 2 million persons) may have exposures as high as 75-100 WLM over a lifetime from natural background radon daughters. As noted previously, only about 1% of underground uranium miners have exposures of 3-4 WLM in a given year. Further, the risk to miners from radon daughters is comparable to, or less than, the occupational risk of other workers in other industries including construction, agriculture, transportation/public utilities and government.

Industry, the Bureau of Mines and MSHA have worked over the last 20 years to minimize miner exposure to radon daughters and, in our view, have succeeded admirably. Current radon daughter control systems and training programs have maintained long term cumulative exposures to very low levels - well below the levels at which significant excess lung cancers have been observed.

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Senator BINGAMAN. Thank you very much, Charles. At this point, let me defer to Senator Domenici. He has an appointment that he needs to rush to but wanted to make a statement before he left. Go right ahead.

Senator DOMENICI. Thank you very much, Mr. Chairman. Let me first thank Mr. Harrison, Mr. Joe, Ms. Nakai, Earl Mettler, and you, Charles Roybal, for appearing here today.

Let me say to the Navajo people, the Chairman has just indicated that I have to leave. I think the meeting is coming to an end, but I have an appointment in the city of Las Vegas, New Mexico, and I had arranged it before we arranged this meeting. So the Chairman is going to hold me excused, and I hope you will, but I want to just make a brief statement.

Frankly, I've been working on this issue for about 11 or 12 years. I did not think we would ever get to the day where we would have a bill which will, in a small way, make up for the mistakes that were made in the early days of uranium mining in the U.S., but we do.

Let me say to all of you that we claim and take a great deal of pride in our nation in trying to be just, in trying to be civil, and yes, in trying to be compassionate. And we have, from time to time, even in the recent past, attempted to make up for past mistakes.

This is an occasion, an opportunity, in my opinion, for the U.S. Government to make amends for mistakes that were made in the early years of uranium mining. We will never make up for what really happened. We can never replace family; we can never replace those Navajo miners and others who have died, nor can we make up to those who are currently desperately ill, but we, when we pass this bill, will take one giant step in acknowledging that we ought to do something, and it ought to be significant, and what we can best do is to compensate.

So I hope we will get this job done in the very near future. I will join with Senator Bingaman in trying to get this bill through the Senate. Hopefully, before the year is out, we can have, instead of a meeting filled with grief, rather have one that has a bit of celebration; not total, but a bit, where we have acknowledged and will start compensating those who helped America remain strong and who have suffered for it. Thank you very much.

[General applause.]

Senator BINGAMAN. Thank you very much. We have run over the time we had expected to be here. And let me also join with Senator Domenici in thanking the witnesses from this panel. I think the testimony of Mr. Harrison and Raymond Joe and Ms. Nakai has been very helpful in allowing us to understand what the real human result of this problem has been.

I also appreciate very much Earl Mettler and Charles Roybal testifying about the difficulties—Earl Mettler testifying about the difficulties of getting compensation or relief through the traditional standard legal system that we have in place, and, of course, the Mining Association for its presence and interest in seeing justice done.

I would just repeat that this is not an occasion for celebration, and this hearing was not intended as that. I do think it is an occasion for hope. I do believe there is a real possibility—not a guaran-

tee, but a possibility—that the Congress will move ahead and act responsibly and pass some version of this legislation this year.

And Senator Domenici and I are both working to try to accomplish that. We are hopeful that something can be done, and I think the testimony we have taken here today will be very helpful to us in making the case to our colleagues in the Congress that this type of relief is needed.

Following this hearing, which we are about to adjourn, let me just advise everybody that there will be a question-and-answer session. Some of the witnesses, including Stewart Udall and Lynda Taylor, Phil Harrison and representatives of the Navajo Tribe, including legal counsel, will be here to answer questions that you may have regarding the legislation we discussed today.

I would encourage all of you who would like to stay, if you need more information. I would ask that Perry Charley translate this announcement, so that everyone here can understand that there will be an opportunity to ask questions and to get answers immediately following the adjournment of this hearing. Perry, if you would do that before we adjourn the hearing, I would appreciate that.

[Senator Bingaman's remarks translated to Navajo language.]

Senator BINGAMAN. Thank you very much. And let me also, before I adjourn here, thank Perry Charley and Mr. Leonard for the help they gave us in organizing this hearing today and thank the folks at Shiprock High School for the use of this facility and thank all of you for coming and for showing your interest in this important matter. And we will try to succeed in getting some relief for you.

With that, we will adjourn the hearing. Thank you all for coming.

[Whereupon, at 11:25 a.m., the hearing was adjourned.]

APPENDIX

Additional Material Submitted for the Record

RESOLUTION OF THE
FORMER NAVAJO URANIUM MINERS
TONALEA CHAPTER
THE NAVAJO NATION

REQUESTING THE UNITED STATES CONGRESS, LABOR AND HUMAN RESOURCES COMMITTEE FOR CONSIDERATION OF THE AIRBORNE IMPACT OF THE URANIUM DUST AND RADAR FROM THE MILL PROCESSING PLANT IN WESTERN NAVAJO AGENCY AND THE GENERAL PUBLIC REQUESTS THE SAME CONSIDERATION FOR MONETARY COMPENSATION UNDER "RADIATION EXPOSURE COMPENSATION ACT" CURRENTLY CONSIDERED FOR LEGISLATION.

WHEREAS:

1. The Tonalea Former Uranium Miners is a local governmental entity, vested with authority to act in the best interest of its constituents relating their needs, problems and general well being; and

2. According to testimonies through duly called assembly held with the past Uranium Mill Workers, it is understood that the Uranium Processing Mill Workers were by far more exposed to the raw (Yellow Cake form) form of Uranium. Therefore the latency effects exceeds the latency effects prescribed for a underground mine workers; and

3. The raw uranium (Yellow Cake), therefore has the same latent effects when Airborne by the high winds that are often prevalent on the vegetation, crops, animal, water source, land and human lines; and

4. The people and animals depend and enter-depend on the essence of vegetation, crops, land and water for life and survival; and

5. The Navajo Nation needs the United States government to honor the Spirit of the 1868 Treaty in protecting the rights of the Navajo people and not legitimize its mistake by not providing adequate legislations protection; and

6. The concerns of the assembly express they be treated with the same consideration due to their disabilities and diease transmitted from the household member employed and unprotected mill processing operation ducing high winds which carried the dangerous dust particle of Uranium.

NOW, THEREFORE BE IT RESOLVED THAT:

1. The Tonalea Former Navajo Uranium Miners hereby strongly supports the passage of S-841 and H.R. 2372 to provide jurisdiction and procedures for claims for compassionate payments for injuries due to exposure to radiation from Uranium Mining and processing (Radiation Exposure Compensation Act).

Con't Resolution of the Uranium Miners
Page 2 of 2

2. The Tonalea Former Navajo Uranium Miners highly recommends that language by included in the proposed legislation to have compassion on the Navajo people affected by the high winds Airborne Uranium dust particle which adversely affected all aspect of their livelihood.

C E R T I F I C A T I O N

WE HEREBY CERTIFY THAT THE FOREGOING RESOLUTION WAS DULY CONSIDERED AT A DULY CALLED MEETING AT TONALEA, NAVAJO NATION, ARIZONA, AT WHICH A QUORUM WAS PRESENT AND THAT THE SAME WAS PASSED BY A VOTE OF -48- IN FAVOR AND -0- OPPOSED ON THIS 8th DAY OF MARCH, 1990.

John Fowler
JOHN FOWLER, COMMITTEE PRESIDENT

Mike Kiyaani
MIKE KIYAANI, COMMITTEE, VICE-PRESIDENT

Renda Fowler
RENDA FOWLER, COMMITTEE SECRETARY

Billy Reese-Kee
BILLY REESE KEE, COUNCIL DELEGATE

RESOLUTION OF THE FORMER NAVAJO URANIUM MINERS AND MILL WORKERS
TONALEA CHAPTER
WESTERN NAVAJO AGENCY

REQUESTING THE LABOR AND MANPOWER COMMITTEE OF THE UNITED STATES CONGRESS NOT TO EXCLUDE URANIUM PROCESSING MILL WORKERS, DUST INDUCEMENTS, RADIATION AND EXPOSURE TO YELLOW CAKE (PROCESSED URANIUM POWDER).

WHEREAS:

1. According to testimonies through congregated meetings held with past Uranium Mill Workers of 1900 era, it is understood that Uranium Processing Mill Workers were by far more exposed to raw (Yellow Cake form) form of Uranium. Therefore the latency effects exceeds the latency effects prescribed for a underground mine workers; and

2. Specifically, justifying with evidential proof is employees who worked in the Scale House, Ore Yard, Sample Plant, Crushing Plant, Grinding Circuit, Flotation Circuit, Uranium Leaching Circuits, Counter-current washing of barren solids, solvent extraction, yellow cake precipitation, tailing disposals have actually handled Uranium in a highly raw form throughout other mill sites without set EPA approved safety protectants, devices, etc.; and

3. The victimized are also wives and children of mill employees, by transmitting worksite contamination at homesteadings. Another is by residing near mill site premises; and

4. The most concern lies where the United States Government, deliberately allowed the "jeopardization" of the the lives of all mill workers through "prolonged radiological exposure"; and

5. The United States Government should recognize and assume fiduciary responsibility for the irreparable harm done to these Navajo individuals, as expressed in 1868 Treaty, Agreements, Statutes, Executive Orders, Administrative Orders and Judicial pronouncements; and

6. The 1868 Treaty makes the Navajo Nation unique sovereign government and the United States Government should honor the content and intent of that treaty; and

7. During the time of Uranium processing activities, there were ineffective and improper safety equipments, there were no formal public education or training, lack of or improper regulations, not to mention sub-standard wages that were prevalent for the people. The living conditions were in delipidated standards thereby it enforces health and social problems; and

8. The transportation of Uranium from the mine to ore yard were just as dangerous and more so during its milling process, therefore the Franks' Amendment should not exclude Uranium Mill Workers in the H. R. 2372, because the objectives are the same.

NOW, THEREFORE BE IT RESOLVED THAT:

1. The Former Navajo Uranium Miners and Mill Workers request the Labor and Manpower Committees of the United States Congress not to exclude Uranium Processing Mill Workers, Dust inducements, Radiation and exposure to yellow cake (processed Uranium powder) from H. R. 2372.

C E R T I F I C A T I O N

WE HEREBY CERTIFY THAT THE FOREGOING RESOLUTION WAS DULY CONSIDERED AT A DULY CALLED MEETING AT TONALEA, NAVAJO NATION, ARIZONA AT WHICH A QUORUM WAS PRESENT AND THAT THE SAME PASSED BY A VOTE OF 46 IN FAVOR AND 0 -OPPOSED, ON THIS 8th DAY OF March, 1990.

John Fowler
JOHN FOWLER, COMMITTEE PRESIDENT

Mike Kiyaani
MIKE KIYAANI, COMMITTEE VICE-PRESIDENT

Renda Fowler
RENDA FOWLER, COMMITTEE SECRE.

Billy Reese Kee
BILLY REESE KEE, COUNCIL DELEGATE

RESOLUTION OF THE FORMER NAVAJO URANIUM MINERS
WESTERN NAVAJO AGENCY
THE NAVAJO NATION

SUPPORTING "THE RADIATION EXPOSURE COMPENSATION ACTS," INTRODUCED AS S. 841 AND ITS COMPANION BILL H.R. 2372, AS WELL AS OTHER PROPOSED BILLS, THAT PROVIDE JURISDICTION AND PROCEDURES FOR CLAIMS ON DAMAGES AND INJURIES RECEIVED DUE TO RADIATION EXPOSURE FROM URANIUM MINING.

WHEREAS:

1) Former Navajo uranium miners of the 1940's to 1970's mining era within the Four Corners area, in a united effort are addressing their support and concern on issues relating to current attempts to introduce compensation bills that would provide damage awards,

2) There has been for many years, a clear need to provide reparation in terms of monetary settlements and provisions of better health care for uranium miners afflicted with lung cancer and other serious respiratory disease, as a direct result of exposure to radioactivity while engaging in underground uranium mines,

3) That the United States Government, as the sole procurer of the uranium ore, had adequate knowledge of the hazards involved, deliberately allowed prolonged radiological exposure of the Navajo miners, even to the point of retaining the Navajo miners as an exculpatory study group,

4) The Navajo uranium miners played a vital role in assuring the success of American's nuclear industries, at the expense of their health, their lives and those of their families,

5) These miners agree with the August 1985 administrative decision initiated by the United States Court od Appeals, Ninth Circuit, where the court "agree with the District Court that this is the type of case that cries out for redress, but the courts are not able to give it; Congress is the appropiate source in this instance" (John Begay, et al,. vs. United States of America: Stewart L. Udall, Phoenix, Arizona for Plaintiffs/Appellants, No. 84-2462).

6) That the former uranium miners recognize that mill workers were also exposed to uncontrolled amount of radioactivity during the ore processing procedures and that the mill workers are not included in S. 841 and H.R. 2372.

THEREFORE BE IT RESOLVED THAT:

1) The Navajo uranium miners do hereby fully support the Radiation Exposure Compensation Acts, S. 841 and H.R. 2372 and all other future bills that would provide jurisdiction and procedures for claims on damages/injuries received due to radiation exposures from underground uranium mining activities,

2) In addition to monetary relief, the United States Government is obligated to provide immediate relief in improving health care specifically designed for former uranium miners and their families,

3) Navajo uranium miners, also recognizing that certain language in both S. 841 and H.R. 2372 require modifications, urge the Navajo Tribal Council to assist in such modifications, provide supportive efforts of both Bills, and urge the Navajo Tribal Council to contact and urge respective delegate members of the states of Arizona, Colorado, New Mexico, and Utah to co-sponsor both Bills,

4) Former mill workers be included into both S. 841 and H.R. 2372 subject to the same administrative jurisdiction and procedures for claims on their damages and injuries,

5) The Navajo uranium miners also request a Public Hearing on both Bills to be held in and conducted on the Navajo Reservation and that all appropiate Tribal entities provide expert assistance and witnesses to accomplish this.

C E R T I F I C A T I O N

WE hereby certify that the foregoing resolution was duly considered by the Navajo uranium miners, at a special called public meeting held at Tonalea Community Chapter House, Tonalea, Navajo Nation, Arizona, at which this resolution was passed by a vote of 47 in favor, ~~0~~ opposed and ~~0~~ abstentions, on this 3rd day of October, 1989.

John Fowler, Chairman: Protempore

Mike Kiyaani, Vice-Chairman: Protempore

Linda L. Fowler, Secretary: Protempore

RESOLUTION OF THE FORMER NAVAJO URANIUM MINERS
TONALEA CHAPTER
THE NAVAJO NATION

SUPPORTING "THE RADIATION EXPOSURE COMPENSATION ACTS," INTRODUCED AS S.841 AND THE COMPANION BILL H.R. 2372, AS WELL AS OTHER PROPOSED BILLS, THAT PROVIDE JURISDICTION AND PROCEDURES FOR CLAIMS ON DAMAGES AND INJURIES RECEIVED DUE TO RADIATION EXPOSURE FROM URANIUM MINING.

WHEREAS:

1. Former Navajo uranium miners of the 1940's to 1970's mining era within the Four Corners area, in a united effort are addressing their support and concern on issues relating to current attempts to introduce compensation bills that would provide damage awards,

2. There has been for many years, a clear need to provide reparation in terms of monetary settlements and provisions of better health care for uranium miners afflicted with lung cancer and other serious respiratory disease, as a direct result of exposure to radioactivity while engaging in underground uranium mines,

3. That the United States Government, as the sole procurer of the uranium ore, had adequate knowledge of the hazards involved, deliberately allowed prolonged radiological exposure of the Navajo miners, even to the point of retaining the Navajo miners as an exculpatory study group,

4. The Navajo uranium miners played a vital role in assuring the success of American's nuclear industries, at the expense of their health, their lives and those of their families,

5. These miners agree with the August 1985 administrative decision initiated by the United States Court of Appeals, Ninth Circuit, where the court "agree with the District Court that this is the type of case that cries out for redress, but the courts are not able to give it; (John Begay, et al,. vs. United States of America: Stewart L. Udall, Phoeniz, Arizona for Plaintiffs/Appellants, No.84-2462),

6. That the former uranium miners recognize that mill workers were also exposed to uncontrolled amount of radioactivity during the ore processing procedures and that the mill workers are not included in S. 841 and H.R.2372.

THEREFORE BE IT RESOLVED THAT:

1. The Navajo uranium miners do hereby fully support the Radiation Exposure Compensation Acts, S.841 and H.R.2372 and all other future bills that would provide jurisdiction and procedures for claims on damages/injuries received due to radiation exposures from underground uranium mining activities,

2. In addition to monetary relief, the United States Government is obligated to provide immediate relief in improving health care specifically designed for former uranium miners and their families,

3. Navajo uranium miners, also recognizing that certain language in both S.841 and H.R.2372 require modification, urge the Navajo Tribal Council to contract and urge respective delegate members of the states of Arizona, Colorado, New Mexico, and Utah to co-sponsor both Bills,

4. Former mill miner workers by included into both S.841 and H.R.2372 subject to the same administrative jurisdiction and procedures for claims on their damages and injuries,

5. The Navajo uranium miner also a Public Hearing on both bills to be held in and conducted on the Navajo Reservation and that all appropriate Tribal entities provide expect assistance and witnesses to accomplish this.

C E R T I F I C A T I O N

We hereby certify that the foregoing resolution was duly considered by Tonalea Chapter at a duly called meeting at Tonalea, (Navajo Nation), Arizona at which a quorum was present and the same was passed by a vote of 4/ in favor and 0 opposed on this 27th day of September, 1989.

Joe Dayzie, President

Joe Klain Sr., Vice-President

Billy R. Kee, Council Delegate

Grey Farrell Jr., Secretary

March 09, 1990

My name is Lucille Begay Manygoats. My parents are Roy Begay (deceased) and Agnes K. Freeman. I am 35 years old and living at Tonalea, Arizona. My social security number is 527-90-4094. My census number is 075,903. My husband name is Jack W Manygoats. I have three children - Jason Manygoats (17), Dawn M. Manygoats (15) and Aaron J. Manygoats (10).

My mother tells me when we were little we used to live at Rare Mental and at Cameron, Arizona. We followed the job site where my father worked. My father worked for the Uranium Mine at Rare Mental. My mother said we used to play in the dirt that were dugged out. I remember my father had some problem with his ear. And all of us family wear glasses. Maybe that has to do with the mine. I have one older sister and two younger sister and one brother at the time when we lived there at the mine. also, I had one brother that died right after 2 weeks after birth.

My grandfather and my grandmother on my dad side both died of cancer. Hooner Begay and Nellie Begay. Both used to live at Rare Mental Mine too. At the time when the mine was open.

Lucille Manygoats
Box # 95
Tonalea, Az 86044

Agnes Freeman,

Stated that she was living with her family near the mining site so her husbena would work there. They lived in tents and her children were raise there. Now they are experiencing health problem, and there doctor has stated that some of the problem were related to Uranium contemination. For example: Anges's daughter Stella got a lumb on her throat and was remove,now she has to take medication on a daily basis. One dauther die of liver infection and her son was also treated for liver infection but they are both deceased. Agnes herself, is have problem with her eye been sore and running, sometimes it is painful. At times it goes away, but it usually return when, the wind blows.

99

To whom it may concern:

My name is Lisa [illegible]. I am 21 years old. My social security is 588-[illegible] and my Crisis number is 325,[illegible]. I have a child her name is Crystal [illegible]. She's [illegible] old now. I'm not married to her father yet but we have a common-law marriage. My parents are Ray Bragg (deceased) and [illegible] kinds to [illegible]. My mother use to tell us about my father working for [illegible] Line at [illegible] Hotel and Coalmine, &c. I was'it born yet, but my mother said my father, her and my older sisters and brother use to live at [illegible] Hotel. I had an older brother [illegible], but he died as an infant. My grandfather Hoover Bragg and my grandmother Nellie Bragg also use to live at [illegible] Hotel [illegible].

Sincerely,
Lisa [illegible]

31-121 253

My husband worked in Yuba City Rare Metals and Passed away, his name was Eddie Daw. We lived there for about 5-6 years. We had no washing machines we washed the clothes my husband came home ex, with water scarcity we hardly changed the laundry water and we mixed our own (mine and our childrens clothes) and we lived in tents. My children Lillie, Eddie Jr., Roger, Fred, Ray Mary Daw whom were my children. Presently 3 of my children are experiencing lesion like sore on the legs and swelling of legs too. For myself I developed needle like lumps on my chest & had to be removed surgically. The doctors diagnosed it as Cancer.

Signature: Lillie Graham

Lillie Graham

Jimmie Donald, Cow Spring T.P. Tonalea, Arizona 86044
Census # 75721 SS# 527-44-3443

He was employed for the Uranium Mine Company that is located near Tuba City. He worked as a driller. During his employment, his supervisor never inform he of the Health Harzards, and has never took safety procaution, like wearing protective clothing, face mask, etc. They ate there meals out door, at times in the blowing wind, the dust going into there meals, eyes, ears, and lungs.

They live near the mine in tents and got there drinking water from a barrel, which might have been conteminate. There bedding, clothing and cooking utinsel, pot and pan were not sheltered form the blowing dust, and conteminated them. There Children played near the mining areas, lived, breath, and walked the contemination from the Mining.

Mr. Donald has been experiencing health problem, arthristis in the joints, at times, his heart and lungs seems like they are not strong enought to take him through a minor task. His eye sight is deteriating, his to wear glasses. His doctor told him not to work and perform any strenuous task, therefore he is unable to provide adaquately for his family, has to depend on social assistance. His family also has had problems with their health. Some had survery performed on there ears, and problems with there eye sight.

I resided on the premises of a
Uranium Mill and lived there
4 years, and my son worked
at the mill. To my knowledge
the water and food would have
been consumed contaminated with
uranium land or by products. I am
presently 18 years old a Navajo
Indian. Presently I am experiencing
problems with my breathing and
heart problems which I associate
with exposure to uranium. I
would be very thankful if
you would consider my testimony
and mill workers, and residents
of people in the area of mill
site to be compensated for the hardship
I have endured
as a direct result of uranium Mills

Jimmy Yazzie Claw

Susie Claw
P.O Box # 24
Tonalea, Az 86044

Concerning Jimmy Yazzie Claw
My husband worked for uranium back in 1955 to 1971.
He started working at the Scale House, ore yard sample plant. Crushing plant Grinding Circuit, Uranium, leaching Circuit, Counter current washing Barren Solids solvent Extraction Yellow Cake, precipitation. Have actually handled uranium in high raw form throughout mill sites without EPA approved safety protectant, devices, etc.
The victimized are also wives and Children of mill. By transmitting Worksite Contamination, another is residing near the mill site.

RESOLUTION OF THE FORMER NAVAJO URANIUM MINERS
TONALEA CHAPTER
THE NAVAJO NATION

THE SIGNATURIES HEREBY FULLY SUPPORT SENATE BILL 841 AND H.R. 2372 AND OTHER LEGISLATIONS AND REQUEST FOR MONETARY RELIEF FROM UNITED STATES GOVERNMENT AND THE SIGNATUREIES BE INCLUDED IN PUBLIC HEARING TO SENATE BILL 841 AND H.R. 2372 AND BE SUBJECT TO THE SAME CLAIM.

WHEREAS:

1. Signatories to this resolution were residents near Rare Metals Uranium Processing Plant at the time of mill operation and are still residents of the area; and

2. That there has been for many years a clear need to provide reparation in terms of monetary settlements and provision of better health care for Uranium Miners affected with lung cancer and other resperetory because due to explosure to uranium radiation agents, while living close to uranium processing plant at Rare Metals Plant near Tuba City Arizona, the western part of the Navajo Reservation; and

3. That since the signatories were residents near this processing plant, their reason to believe that they were exposed to this radiation agents, which is hazardous to their health, and their livestock as well as members of thier household; and

4. United States is tne sole procurer of the Uranium, and had adequate knowledge of the hazards produced by uranium, which was never related to the signatories or their dependants; and

5. That Navajo Miners and Mill Workers played a vital role in assurring the success of American's Nuclear industires and the National Defense at the expense of their lives and families; and

6. That United States Government under 1868 treaty agreement with the Navajo Tribe, has promised to act of as fiducary agent in health, education and at the will of the Navajos, as long as the treaty remains in effect; and

7. Therefore since United States has failed to informed the signatories of hazards caused by uranium radiation agent, United States has failed to honor its treaty agreement with the Navajo Nation; and

8. That has been no information given by United States Government to the signatories of this resolution of the hazards that can be caused by radiation exposure to health and livelihood, the signatories to this resolution should be included in Senate Bill 841 and H.R. 2372 along with the Uranium Miners and Uranium Processing Mill Workers.

Con't on Resolution of the Uranium Miners
Page 2 of 2

THEREFORE BE IT RESOLVED THAT:

1. That signatories to this resolution do hereby fully Senate Bill 841 and H.R. 2372 Radiation expossure Compensation Act and all other future legislations along the underground Uranium Miners and Uranium Processing Mill Workers and the same be included in S-84 and H.R. 2372.

2. That in addition to monetary relief, United States Government as fiducary agent provide immediate relief in improving health care specifically to the signatories of this resolution.

3. That signatories be included in a public hearing to Senate Bill 841 and H.R. 2372 and the same be subject to the same administration jurisdictional procures for claim for releif damages to health and injuries.

C E R T I F I C A T I O N

WE HEREBY CERTIFY THAT THE FOREGOING RESOLUTION WAS DULY CONSIDERED AT A DULY CALLED MEETING AT TONALEA, NAVAJO NATION, ARIZONA, AT WHICH A QUORUM WAS PRESENT AND THAT THE SAME WAS PASSED BY A VOTE OF -48- IN FAVOR AND -0- OPPOSED, ON THIS 8th DAY OF MARCH, 1990.

John Fowler
John Fowler, Committee President

Mike Kiyaani
Mike Kiyaani, Committee Vice-President

Renda Fowler
Renda Fowler, Committee Secretary

Billy Reese Kee
Billy Reese Kee, Council Delegate

Date	
	John Acothley C# 71,550 DOB 07-10-25
	Ruby Acothley C# 77,180 10-01-30
	Melvin Acothley C# 81,201 01-28-55
	Rosebelle Acothley C# 109,125 01-22-54
	Jaclya R. Acothley 07-28-86
	Derek R. Acothley 07-28-88
	Raymond Acothley 300,046 09-19-58
	Linda " 300,824 07-05-60
	Marsha " 318,662 01-18-79
	Deidre 325,037 10-27-85
	Cara J. Bia C# 303,766 10-28-63
	Andrew Bia C# 501719 01-27-62
	Bia, Marshall Jon C# 523,687 09-24-84
	Acothley, Freddie C# 307-709 02-04-62
	Acothley, Janice C# 305, 399 02-25-65
	Acothley, Devida Lee 08-26-89
	Acothley, Robert C# 301-775 05-29-60
	Acothley, Yvonne C# 602 585 03-11-62
	Acothley, Robin C# 323, 758 09-21-84
	Kelsey D Acothley C# 308 [illegible] 10-16-03
	Eugene Scott Jr C# 301, 814 01-16-68
	Justin N Scott C# 02-18-81
	31-121 260

	Lena Saganitsco	C# 071,485	DOB: 1892	SS# 527-40-8223
	Katie Huskon	C# 071,489	DOB 5/28/23	SS# 527-26-5590
Hd	Lillian M. Begay	C# 111,316	DOB: 8-12-59	SS# 585-82-3155
dau	Sharon Begay	C# 317,596	DOB: 12-18-77	SS# 527-93-3333
son	Shawn D, Begay	C# 320,637	DOB: 7-24-81	SS# 527-17-4594
Hd	Bryan Huskon	C# 306,627	DOB 04 10 06	SS# 527 37 3728
dau	Felicia, K. Huskon	C# 321,188	DOB 06-29-81	SS# 601-52-9290
	Bridget Huskon	C#	DOB	SS#
Hd	Floyd Huskon			
Wife	Phyllis Huskon			
Son	Philbert Huskon			
Son	Flapbert Huskon			

March 13, 1990

To:Red Lake Chapter Office,

To whom it may concern, we wish to remind you that we are concern about our health too, as much as others that reside here at Rare Metals.

I Victor Saganitso a resident of Rare Metals, have live and raised my family here since their birth.

I have lived here before the Uranium site was ever in opperation. They came and now they're gone, haven't heard from them since, to do anything about our health.

I have even lost a love one, at the age of 50, my spouse. Now some of us have trouble seeing, ironedly loosing eye sight and poor health. Who will do something about it. I sure believe that we all have been effected by the Uranium. Every other day the wind carries it into our homes, thats how we have been effected. We hear that lots of people are getting pay backs for their health, people seem to over look us, even though we live within 1/4 mile of the Uranium site, Rare Metals. That was open and now closed.

These are my children I wish to include. Some live here and work else where. This is our home and nowhere else to go.

Name		Address
Victor Saganitso Jr.	Victor Saganitso Jr.	Box 821 Tuba City Az. 86045
Victor Saganitso Jr.	Victor J. Saganitso	" " "
Davin L. Saganitso	Davin L. Saganitso	" " "
Delvin Saganitso	Delvin Saganitso	" " "
Rose Marie Williams, dau.	Rose Marie Williams	Box 1038 Tuba City Az. 86045
Marie Chee, dau.	Marie L. Chee	Box 821 Tuba City Az. 86045
Lucille . Krause, dau.	Lucille M. Krause	" "
Tillman Saganitso, son	Tillman Saganitso	" "
Justin L. Saganitso, son	Tillman Saganitso	Box 1246 Tuba City Az. 86045
Shirley A Saganitso, dau.	Shirley A. Saganitso	" " "
Randy L. Saganitso, son.	Randy L. Saganitso	" " "

Some of them have raised their children here too, my grandchildren.

Thank You

Sign Victor Saganitso Sr.

JOHN FOWLER
P. O. BOX 4
TONALEA, ARIZONA 86044
HOME PHONE: (602) 283-5698

TESTIMONY OF MR. JOHN FOWLER

As a former Uranium Mill Worker at Rare Metal, Arizona and at Mexican Hat, Utah, within the mid-1950's throughout early 1960's, I, Mr. John Fowler, strongly oppose being exempt and not being considered for the Radiation Exposure Compensation Act.

On preliminary basis to support my opposition is due to the 1868 Treaty established by the U. S. Government. Within this treaty, the U. S. Government condoned themselves to carry out its provisions. For one provision in particular was ensuring health care and safeguarding the Navajo people from any health endangerment. However, it was jeopardized by deviating from the guidelines established. This by opening uranium mines and mill plants throughout certain areas of the Navajo Reservation for the interest of the nation's defense purposes.

Secondly, the U. S. Government knew of the toxicity of the uranium but simply waived all its safety precautionary guidelines by various affiliante who regulates those requirements. At that instances with a very minimal educational background, I have worked as a all around Mill Operator within a uranium mill plant process. But I want to emphasize on several areas where I was exposed to a pure form of Uranium with it's dust, vapor and radioactivity forms and are as follows: As a Yellow Cake Operator, in this capacity I operated a hot roller at final uranium drying process stage. Here I was exposed to enormous amount of steam given off from the pure uranium form before I packed barrel containers and sealed prior to shipment from mill plant sample prep operator, my duty here was to clean areas where high and low grade was to be separated and at no instance to be left uncleaned. Air hosing all equipment and machines with

creating tremendous amount of dust from uranium and with no protective clothing or breathing apparatuses to protect my health. I recall that an anglo worker had a heart attack at that capacity supposedly due to uranium overcoming his health.

At the crusher plant operator position I inhalated tremendous amounts of uranium dust and wore no protective clothing to protect my health.

The point here is that no protective clothing, devices, apparatuses and equipment were recommended by employer and various Occupational Safety Health Administration and National Institute for Occupational Safety and Health Organizations. Workers were merely exposed to the refined form of uranium in a dust form combined with other minerals.

Not only was I exposed to radiation from uranium. My family resided with me near the mill site. While covered with uranium dust and not knowing its effects, my children would greet me every evening after a day's work at the mill. Doing so, I usually held and carried my children back to our tent located near the mill site. My wife also washed my contaminated clothing each day by hand. The more I think back and recall those moments, I can not undo what damage is done. Ultimately, I feel that a explanation to replenish at least to alleviate the unforgiving act of the U. S. Government is due here.

Finally, I enclose my testimony by stating that even supplements are awarded to foreign countries to pursue political sanctuaries but our devotion is long ago token by our dedicated service for the United States of America.

John Fowler

P.O. Box # 11
SHIPROCK, NEW MEXICO 87420
MARCH 13, 1990

HONORABLE SENATORS,
PETE DOMENICI and JEFF BINGAMAN
STATE OF NEW MEXICO

Indeed it is of the very utmost to have your presence here in Shiprock, New Mexico, welcome to our homeland, the Navajo Nation. Your presence also show our Navajo people your care about a grave expierence to my family in the past. I personally do not know you, but have heard your name on the Navajo radio stations from our surrounding towns. I say this, hear your name, because I do not speak or write, nor read the English language. Again, I say welcome and I personally want to thank you for your presence.

My name is Jessie Yazzie, born and raised in Beclabito, New Mexico. A small community in the northwest part of New Mexico, about one mile from the Arizona border. I have five(5) children, four(4) girls and one(1) boy. My husband, Tom Yazzie, died in the year 1950.

The 'crux' of my letter is to let you know the bad effects, as I find out years and years later, that the uranium mining has had on my family. I and some of my children now blame the side effects that what I now hear of the uranium industry's 'make the quick buck' and move on is so true. I will list a few very sad and agonizing experiences with myself and children. First, my husband was a uranium miner in New Mexico and Colorado, as I can recall. Close to our home in the Bedabbito area, the blasting and probably dust on my husbands clothing were deadly, but unknown to us. My children would run to meet their father coming home from a day in the mines, allowing the dust to float freely in our daily living quarters and lives. When my husband died, we took him to several hospitals, but the doctors evidently knew what it was, but never really told us the truth. Now I blame the uranium mines that he worked for. I myself have had to be away from my kids for a period of five (5) years, when my kids were all small, to a Sanatorium Hospital in

Tucson, Arizona. This expierence is what I mean by sad and agonizing, thinking back. My Children were raised by others, never really having a place to a home of their own while I was in the hospital. My oldest daughter was placed in another Sanatorium Hospital in Pueblo, Colorado, for illnesses called tuberculosis (TB). One of my daughters lost all her hair when she was very young, and made fun of. My only son has had problems with his leg, limping when he hurts. Two of my daughters are now in the education field, as students on a field trip to Los Alamos National Laboratory, Los Alamos, New Mexico, went through a radiation check station. My two daughters out of about twenty(20) students and sponsors, were the only two to register on that radiation meter. It seemed funny to them then, but now the more the uranium radiation is mentioned, the meter registering isn't so funny. It is telling me something grave and dangerous. These are a few but most, again, sad and agonizing expierances I have had with my childrens. I can go on, but I hope you understand my plea. I have asked and tried to get help

from my own people, but due to my very limited understanding of the English language, I am defeated. But, defeat will not overcome me, I am now going to strive to overcome my defeators, with your help, I am going to come out a triumphant WINNER.

I will list myself and children for your information, in case you need to know more details.

① JESSIE YAZZIE SS# 585-09-0291 C# 29793
P.O. Box # 11 DOB 6/4/24
SHIPROCK, NEW MEXICO 87420

② LORENA SMITH SS# 525-52-9811 C# 29586
P.O. Box 311 DOB 9/8/41
KIRTLAND, NEW MEXICO 87417

③ LOUISE R. GOLDTOOTH SS# 529-48-3957 C# 29587
P.O. Box 548 DOB 4/6/43
SHIPROCK, NEW MEXICO 87420

④ MARRI R. BILLIE SS# 527-64-1723 C# 29588
2401 N. DUSTIN, APT. 219 DOB 9/12/44
FARMINGTON, NEW MEXICO 87401 (505) 325-5355

⑤ MAE Y. SANDOVAL SS# 585-28-4775 C# 29589
P.O. Box 1905 DOB 5/8/46
SHIPROCK, NEW MEXICO 87420 (505) 368-5283

⑥ VERNE GILBERT SS# 585-30-7037 C# 29590
P.O. Box 1911 DOB 11/14/47
PAGE, ARIZONA 86040 (602) 698-3322

Again, thank you very much for your interest in our health and welfare for my Navajo people, I know you care. I say to you in Navajo, ahéhee', (thank-you). I am,

Sincerely yours,

x Jessie Yazzie

JESSIE YAZZIE 3/13/90

XC: Interim Chairman Leonard Haskie
Bill Richardson
Family members

Personal Data

NAME of Jackson, P.O Box 315, Monument Valley, Ut 84536
D.O.B September 17, 1934
Place of birth Narrow Canyon, Arizona
Navajo 1/4 - Census Number 10408
Social Security Number # 529-40-9991

I, Frank Jackson started to work for Utah Construction Mining Co. in Wilcox, Arizona, Southeastern, NE AZ for 18 years. We worked both open pit and under ground. We started working when I was 12 years old because I was small and not heavy for the skips buckets. I went down the narrow pit and shoveled ore and came back up with bucket and shovel out the ore. That was my first job as a laborer man. As we worked we progressed and machinery was invented. We learned how to operate each machine that was little due to me. We worked mainly as air compressor machine operator. So I spend a majority of my working time under the mine.

At several places the mine would seep cool water. My family and my self would drink and bath in these water also had our livestock. Working with me at these job sites. When I was in the Navy Veterans school I had no knowledge that there was education vocational riders.

Presently, My physical condition is poor. I had unbearable pain and very tired to be. I will not withstand pain. The Bureau physical doctors and Navajo Doctors gave me care. I had an operation and inside my chest. Wounded and because of pneumonia.

Birth Outcome in the Shiprock Uranium Mining Area

SUMMARY

The role of radiation in the etiology of birth defects is evaluated for 13,329 Navajos born at the Shiprock PHS/IHS hospital, 1964-1981, Alpha exposures to miners from radon progeny (100x the approved four working level months annually) do not reach the gonads directly. For 36 representative miners, the annual gamma gonadal equivalents from Po-210 and mine ore in no case amounted to one-fifth the approved exposure for miners per year (5,000 mR/yr). Gamma radiation exceeding the 25 mR/yr for the public has been demonstrated in residential sections of few mining areas. Over 150 major kinds of birth defects and 350 minor kinds were documented. Based on analysis of all data, radiation exposure was not significantly correlated with birth defects in 266 paired index and control cases in families interviewed. In subanalysis, however, a statistically significant association existed when the mother lived near the mine tailings. A positive trend appeared between birth defects and the number of years a father worked as a miner.

Not for press release at present

Birth Outcome in the Shiprock Uranium Mining Area

Lora Mangum Shields, William H. Wiese, Barbara Charley and Leonard Benally

Uranium mining in the Shiprock area centered in the northeast quarter of the Navajo Indian Reservation within the Four Corners mineral belt. Over a period of more than three decades, a number of Navajos endured a wide range of occupational and residential radiation. The role of radiation in the etiology of birth defects and stillbirths is evaluated for 13,329 Navajos born at the Shiprock, New Mexico, Public Health Service/Indian Health Service hospital during an 18-year period, 1964-1981.

The physician attending at birth recorded the results of each Navajo newborn examination on a standard form used by the Public Health Service. A hospital chart continued each infant medical record chronologically for as long as the individual received health care at the Shiprock facility.

Data encoded for analysis were derived from an abstract of 1) the PHS newborn record with its continuing hospital chart, 2) the mother's hospital record and 3) family interviews available for 266 selected index cases and their matched controls. The field interviews provided family histories of occupational and residential exposures to radiation sources for parents and four grandparents of each newborn. In addition, for a limited number of miners, cumulative working level months of alpha exposure from radon progeny in the mines were available from records at the National Institute of Occupational Health and Safety (now on file at the Centers for Disease Control).[1] The limited gamma radiation exposure from two sources was calculated. 1) From alpha exposures, the estimated gamma gonadal dose equivalents were computed from the disintegra-

Lora Mangum Shields is Professor Emeritus, New Mexico Highlands University, Las Vegas, N.M. William H. Wiese is Chair, Department of Family, Community and Emergency Medicine, University of New Mexico School of Medicine, Albuquerque, N.M. Barbara Charley and Leonard Benally are student research associates at Navajo Community College, Shiprock, N.M.

and Navajo Community College - Shiprock, N.M.

tion of Po-210 from alpha components (Pb-210) deposited internally in bone. 2) Also, gonadal dose equivalents were calculated for the external whole-body exposures from uranium ore in the mine.

The index cases were births with major defects, the stillborn, and infant deaths within the first year. The control for each was the normal birth chronologically nearest the index which matched by 1) sex, 2) the mother's age within five years and 3) gravida within two pregnancies.

Our abstracting of medical records documented a total of more than 150 major and 350 minor genetic and teratogenic anomalies of prenatal origin whether or not manifest at birth. Supplemental information was abstracted from reports on referrals or transfers to other medical facilities for consultation, diagnosis or treatment.

Data from medical records and interviews of families of 266 paired index and control infants were encoded and analyzed. Encoding followed the system published in the International Classification of Diseases (ICD.9CM), 9th Revision, 1980. The prenatal and newborn data analyzed consisted of observations on the 266 matched pairs interviewed for information on exposure of family members to sources of radiation.

Variables analyzed relating to the infant were sex, vital status, weeks of gestation, birth weight (gms), birth length (cms), head circumference (cms) and anomalies. Variables entered for the mother were age, gravida, parity, place of residence, use of alcohol, use of tobacco, marital status and comorbidities. From field interviews, 16 variables were considered for each parent and grandparent.

relation to infant
date of birth
vital status
place of residence
date of death
place of death
cause(s) of death
worked as uranium miner or miller
years worked in mine and/or mill
location of mine
working level months alpha exposure (where available from CDC)[1]
worked at Fairchild electronics plant
number of years worked at Fairchild
years lived in radioactive house
years lived within 0.5 mi of mine tailings or waste dump
years lived within 0.5 mi of mine entrance

The index and control data sets were analyzed using Statistical Analysis System (SAS) packages.

STATISTICAL METHODS

Each dichotomous exposure variable was augmented with a continuous variable. For the categorical exposure variables, we calculated the odds ratio and the corresponding 95 percent confidence intervals. The null hypothesis that the odds ratio equals one was tested with the McNemar's Test.[2] The Wilcoxon Signed Rank Test[3] was used for the null hypothesis that there is no exposure difference between each case-control pair. In addition, odds ratios for the exposure variables to case-control status, adjusting for many confounding variables, were determined using multiple logistic regressions.

During the 18 years (1964-1981) of the study period, certain important environmental changes were in progress in and around Shiprock. 1) Uranium mining and milling continued the decline which had begun in the early 1960's. 2) The two Shiprock tailings piles underwent interim stabilization, the smaller one (25 acres) before 1968, and the larger pile (40 acres) around 1977. 3) Electrostatic precipitators at the nearby Four Corners power plants had reduced emissions to less than two percent by 1975. 4) The Fairchild electronics plant closed in 1975 after ten years of operation. Fairchild had employed 1,200 Navajo women in three eight-hour shifts daily. 5) The University of Utah established a child-maternal health care center on the PHS/IHS hospital compound, providing improved prenatal and pediatric care. The effects of these events were assessed

by classifying infant births into three periods, 1964-1969, 1970-1975 and 1976-1981, and stratifying on them. Effects of other confounding factors, such as the mother's health status at the time of birth of the infant, were also assessed by multiple logistic regression. Analysis was separated into two groups. One group tested mainly the role of radiation in the etiology of birth defects. The exposure variables in this group were fathers who worked as uranium miners or as millers extracting and processing uranium ore, parents who lived near tailings and parents who lived near open mines. The continuous variables, the number of years subjected to each exposure, were accounted for during the time preceding the birth of the infant.

The second group of analyses tested the birth defect risk from the occupational exposure at the Fairchild electronics plant. The categorical variables here were mother and/or father worked at Fairchild with the corresponding continuous variable, number of years worked at Fairchild. The environment at the Fairchild plant could have delivered both chemical and radiation exposures. Krypton-85 was used in quality control to detect flaws in seals on electronics equipment.[4] Cobalt-60 was used to measure thickness of materials being plated. With one exception, the chemicals were organic and inorganic acids, bases and solvents routinely used in the laboratory. The exception, trichloroethylene used as a fat-wax solvent, can easily cross the embryonic membranes and enter the circulation of the fetus. After testing that the interactions between Fairchild variables and uranium operations were not significant, the analyses on the Fairchild exposures were restricted to those cases and controls whose fathers and/or mothers were employed at Fairchild, using Wilcoxon Signed Rank Tests. This excluded non-Fairchild parents who did not contribute to Fairchild exposure data.

For miners whose working level months were available from CDC, birth defects in progeny were tabulated in relation to individual exposures to alpha

radiation and gamma radiation exposures from decay of alpha components reaching the gonads. From cumulative working level months and years of mining, the estimated gamma gonadal dose equivalents were computed based on two correlations. The first was a correlation between the exposure to radon daughter products (CWLM) and skeletal concentration of Pb-210 (pCi/g).[5] The second correlation used was one that has been established between the Pb-210 concentration in the skeleton and the Po-210 concentration in the gonads.[6] The Pb-210 in the skeleton decays to Po-210, which is the primary source of the Po-210 for other body compartments of uranium miners, primarily the liver, kidney, and, to a lesser extent, the gonads. In two other studies,[7] a range of from 300 to 800 mR/yr (mean 550), in external whole-body exposures was estimated to result from uranium in the mine.[8] Since half of this exposure is estimated to reach the gonads,[9] the calculated gonadal dose equivalents from uranium in the mine (275 mR/yr) were added to each annual gamma exposure.

The combination of stillbirths and infant deaths under 12 months was charted by year, 1964-1981. The recurrence of index cases within families was documented.

(continue with next page)

RESULTS

Analysis of 266 paired cases for whom family interviews were secured

Multiple logistic regression tests found no significant effects of certain environmental events around Shiprock on the variables of birth year date in five-year periods (1964-1969, 1970-1975 and 1976-1981) and mother's age in steps of five years (Table 1).

Indicators of mother's health status at the time of infant birth were 1) use of alcohol and/or tobacco, 2) diabetes and 3) urinary tract infection. Only alcohol use and smoking by mothers had significant health effects (P = 1.00) on the case-control status since all 14 alcohol users and all three smokers came from the case group.

For analysis, the 266 interviewed cases with birth anomalies were classified once into 10 categories, some with subcategories, to determine the distribution of cases for each category for each exposure variable (Table 2). Anomalies were further combined into three major classes on the strength of their etiological associations with congenital birth defects. 1) The low association group included death from premature birth or perinatal condition, obstetrical complication, or others. 2) The medium association group consisted of teratogen, hip dysplasia or dislocation, cerebral palsy and/or mental retardation, and/or developmental delays not otherwise accounted for, stillbirths not otherwise accounted for, and death from illness in infancy. 3) The high association group included chromosomal disorder, simple gene mutation or multifactorial, and ear atresia.

The odds ratio and corresponding 95 percent confidence intervals were calculated for each categorical variable together with the McNemar's test of the

hypothesis that the odds ratio equals one (that the odds of exposure for cases equals the odds of exposure for controls) for all anomalies as well as for the three major classifications.

After examining the correlation coefficients among exposure variables (Table 3), radiation exposures and Fairchild occupational exposures were analyzed independently.

A. Effects of exposure in uranium operations

The overall odds ratio was calculated for association of various exposures of mother and father (Table 4-a). In the analysis based on all anomalies, no significant correlation appeared between radiation exposure and birth anomalies. In the subanalysis, however, an association with statistical significance existed when the mother lived near the mine tailings. The association was most evident in the categories thought to have medium level likelihood, particularly deaths from illness in infancy, and were less evident in the kinds of anomalies more hypothesized to have greater likelihood of association with an exposure such as radiation.

The Wilcoxon Signed Rank Tests to analyze the quantifying variables show that there is some difference in number of years of exposure in the mothers in the above group of cases (Table 4-b). This is a crude measure of dose response. Similarly, positive dose effects are found in fathers of cases in terms of years as a miner and years living near mines even though there was no statistical significance in prevalence of cases in these groups. The variable "number of years father worked as a miner" was not significant. However, when number of years father worked as a miner is classified into three durations, 0, 0 to 4 and more than 4 years, and when the association of miner radiation exposure and case-control status is tested using the Mantel Trend Test, a significant trend is evident

in the positive direction (Table 5). The difficulty with the association is that it occurs in the medium level cases. An additional analysis was run to see whether the association with fathers who were miners occurred more in those working in the earlier years when exposure to higher levels of radon would be a likelihood. There was no trend in this direction.

Some literature (?) suggests that risks from various sources of radiation exposure may be linearly combined. In our case, we feel that the exposure dosage of miners (primarily alpha) is different from exposure dosage from living near open mines and tailings (predominantly gamma).

B. Effects of exposures from Fairchild employment

Two variables that tested significant among the seven exposure factors were "father worked at Fairchild," with odds ratio consistently equal to 2 ($p = .035$), and "mother worked at Fairchild," with odds ratio consistently equal to 1.5 ($p = .045$), regardless of which group of confounding variables was being adjusted for in the tests.

We used the reduced data of 98 pairs of which at least one parent worked at Fairchild. However, we stratify only on the three major classifications of anomalies, foregoing the stratification on the 10 categories because of the inevitable small sample size in each group.

Though Fairchild was committed to safeguards to protect the workers, the Fairchild employment odds ratio and Fairchild hazard (by the Wilcoxon Signed Rank data) suggest an overall association between anomalies and employment at Fairchild (Table 6-a, 6-b). Again the cases show up in the low association groups.

We again hesitate to examine combined risk of parents even if both worked at Fairchild. Fairchild employed more women for their dexterity in certain jobs. Men were employed for different types of work. Hence, assumption that

men and women were equally exposed at Fairchild is not appropriate.

After the Fairchild electronics plant moved from Shiprock to California in 1975, solvent wastes leaking from an underground storage tank appeared in well water supplying a nearby Santa Clara County area. In two epidemiologic studies, the California Department of Health Services failed to find sufficient evidence that the solvent leak caused the increase in cardiac defects in 1981 or the increased spontaneous abortions and congenital anomalies identified in the area.[11]

C. Birth outcome to miners with documented WLM alpha and calculated gamma exposures in the mines

The potentially most serious exposure to miners is alpha radiation from inhaled radon gas or from the radon daughters adherent to dust that is inhaled and ingested. Because of low tissue penetration by alpha, however, and limited deposition in soft tissue, gamma rather than alpha radiation reaches the gonads. The limited gonadal gamma exposure from two sources was calculated: 1) from the decay of Po-210 from alpha component Pb-210 deposited internally in bone and 2) from gonadal dose equivalents estimated from the external whole-body exposures from uranium ore in the mine. From reports of external whole-body gamma-ray exposures from two other studies of uranium miners the dose equivalents (QF = 1) to Navajo underground uranium miners from external gamma-ray exposures have been estimated to range between 300 and 800 mR/yr, assuming 1,600 work hours per year in the mine. Since half of such exposure is estimated to reach the gonads, the calculated gonadal dose equivalents from uranium in the mine (275 mR/yr) was added in calculating each exposure.

Exposure to a radon daughter concentration of one WL (300 pCi/l) for 170 work-hours in one month amounts to one working level month (WLM). The Council on Radiation Protection maximum permissible exposure amounts to four working

level months annually for uranium miners (nuclear workers) or 120 WLM during 30 years of mining.[12] For 750 Navajo miners on the reservation, calculated individual cumulative alpha exposures from radon progeny are filed at the Communicable Disease Centers under the name, social security number, birth date and dates of mining for each individual.

Cumulative alpha exposures in working level months documented by NIOSH[13] (National Institute of Occupational Safety and Health) for each of 138 Navajo miners who was a father or grandfather of an index or control birth ranged from a total of 1.7 to 4,416 WLM during a mining career ranging from 0.1 to 22 years. Compared to the approved annual four WLM, alpha radiation exposure in WLM/yr ranged from 0.3 to 469, mean 127, for 22 miners in index families and from 14 to 153, mean 75, for 14 miners in control families.

Table 1 gives for each the years of mining, cumulative working level months alpha exposures to interviewed Navajo miners available from NIOSH, average WLM/yr, mR/yr gonadal dose equivalents from Po-210, cumulative gonadal exposure in mR Po-210, cumulative gamma equivalents from mine ore, total gonadal mR equivalents and infant defects. The figures for alpha exposure available from NIOSH and gamma exposures calculated for Navajo uranium miners might be accepted as representative of exposures to other miners in this study who were not included in NIOSH records.

The mean number of years of mining is not statistically different for 22 index families (eight years) and 14 controls (7 years) with total mining experience in each set from two to 14 years. Compared to the approved gamma exposure of 5,000 mR/yr for miners, annual gonadal equivalents for Po-210 for 22 index miners ranged from 16 to 418 mR/yr, average 129, and for 14 control miners ranged from 20 to 287 mR/yr, mean 79. The cumulative gamma gonadal equivalents for Po-210 for 22 index miners ranged from 36 to 4,732 mR, mean 1,138, compared to a range for 14 controls from 40 to 3,371, mean 739. In no case does the annual gamma exposure approach the

permissible 5,000 mR/yr for miners.

The presence and severity of defects is unrelated to the individual level for annual or cumulative gamma or alpha radiation exposures. The defects in progeny of interviewed index miners receiving the highest recorded WLM and high gamma exposures follow: 2,493 WLM, father (10 yrs mining, 249 WLM/yr, 418 mR/yr), trisomy 21, but mother past age 40; 2,223 WLM, paternal grandfather (13 yrs mining, 171 WLM/yr, 364 mR/yr), stillborn; 2,082 WLM, maternal grandfather (six yrs mining, 347 WLM/yr, 337 mR/yr), osteogenesis imperfecta congenita and mental retardation; 1,394 WLM, father (14 yrs mining, 100 WLM/yr, 208 mR/yr), right cleft lip, bilaterally cleft palate; 976 WLM, paternal grandfather (eight yrs mining, 122 WLM/yr, 139 mR/yr), leukemia, expired; 939, maternal grandfather (two years mining, 469 WLM/yr, 133 mR/yr), hydrocephaly, mediastinal mass, infant death; and 874 WLM, father (11 years mining, 80 WLM/yr, 123 mR/yr), hip dysplasia.

D. Exposure levels in mines

Mine inspection and radiological reports from mining periods in the 1950s and 1960s recorded alpha and gamma radiation levels. Government inspection reports (1954-1967) were checked for several work areas in each of 24 mines in eight locations on the Navajo Reservation.[14] None of the 24 mines exceeded the approved gamma level (0.5 mR/hr). The several alpha values which follow should represent the range in WL for typical reservation mines. One working level, the approved safe alpha reading, was not exceeded in any part of five mines (1954-1967) nor in certain areas of four additional mines. Alpha radiation reached 1.2 to 2.5 WL in six mines and in nine remaining mines at one or more locations measured 4, 7, 10, 15 and 19 times the 1 WL limit.

E. Gamma levels in residential areas; other factors

Few readings of gamma radiation are available for housing areas near mines or mine waste. Off-pile decontamination in the Shiprock area was aimed at reducing the net aboveground gamma exposure rate to less than 10 microroentgens per hour (10 uR/hr) for unrestricted use of the affected area.[15] For six Oak Springs sites surrounding homes built of radioactive dump rock, gamma exposures range from 165 to 521 mR/yr compared to the maximum permissible exposure of 25 mR/yr for the public and 5,000 mR/yr for miners or nuclear workers (Preliminary Radiological Survey).[16] A more recent radiological survey and assessment of gamma readings showed that 17 sites in the Tsetah (Rattlesnake, AZ) mining area as of August, 1988, and 10 sites in Oak Springs as of September, 1989, qualify for immediate abatement (external gamma radiation level greater than 100 uR/hr (>0.1 mR/hr). However, gamma radiation above the permissible level has been demonstrated in residential sections of few mining areas.

One of the variables influencing radiation exposures was the difference in the uranium concentration in the ores from one mining location to another. The vanadium:uranium ratio in ore, for example, ranged, respectively, from 4:1 in Lukachukai Mountains to 9:1 in the Carrizo Mountains.[17] Alpha exposures related

also to mining methods, ranging from low radon levels in open adits on mesa rims, rim cuts, trenches and small open pits to higher levels in inclined shafts and vertical shafts. A room and pillar method or modification of it ~~were~~ was used in larger underground mines.[17] The majority of the mines in the Shiprock area were operated by non-Navajo companies which had the assignment of a lease or mining permit. Navajo miners worked under the supervision of a non-Navajo engineer. Some mines had entire Navajo crews. Kerr-McGee Oil Industries, Inc., which had the largest mining operation in the Shiprock area, employed 65 to 70 Navajos at the mines in the Lukachukai Mountains.[18]

Navajo producers controlled the typical small reservation mine in the 1950s, a 5- to 8-man operation which tunneled in from a mesa rim. Miners blasted and returned a few hours later or a day or two later to remove the blasted ore[19] when the dust had settled. Production declined at the smaller operations as exposed ore in outcrops and in the mines was depleted and no exploration occurred.[20] When milling in Shiprock ceased operation in 1968, the mines in the Shiprock area had produced some 882,000 tons of ore with an average grade of 0.23 percent U_3O_8. Some 180 small uranium mines in the Shiprock area were abandoned, leaving open shafts, following the extraction of the higher grade ore.

II. Time trends for the incidence of 500+ kinds of anomalies in 13,329 births

Time trends were examined for the incidence of anomalies by diagnosis in the entire data set. Analysis does not identify any consistent pattern of change in incidence for any of the major diagnostic categories over the time span of the survey. For five major defects, however, incidence rates were significantly higher in the 7,431 births during the 11-year period, 1964-1974, compared to the 5,898 ~~births~~ births during the seven-year period, 1975-1981. The five conditions significantly higher for the period 1964-1974 range in percent incidence from 1.6 to 3.5 times as great as for 1975-1981: harelip/cleft palate, 1.6; hip dysplasia, 1.8; mental retardation, 2.7; hydrocephalus, 2.0, and club foot, 3.5.

In 1980, the Council on Environmental Quality published a report which singled out San Juan County, New Mexico, nationally as having an extraordinary high rate of congenital anomalies as listed on birth certificates in the years 1973-1975.[21] San Juan County incorporates much of the Shiprock uranium mining area within the northeastern edge of the Navajo Reservation. Our independent review of birth certificates for 1973-1975 suggests that the excess of anomalies might be accountable to 1) reports of hip dysplasia, heart murmur and minor defects of the male reproductive tract in newborn at the Shiprock PHS/IHS hospital or to 2) unusually conscientious reporting at this hospital on newborn examinations by nurse midwives provided the hospital by the University of Utah at this time.[22]

Because of the delayed appearance of many defects, early diagnosis is unreliable. In our study of Navajo births, however, access over a period of years to the continuing individual PHS/IHS medical records permitted listing of delayed maturational and functional disorders of prenatal origin.

Data abstracted from the Navajo newborn examination and continuing medical record can be compared with only that published by Neel[23] and by Niswander et al.[24] who reported defects which were diagnosed and recorded within a few days following each birth rather than at once from birth certificates. For approximately half of the Japanese newborn, defects were confirmed following a second examination between the ages of eight and ten months.[23]

Among 13,329 Havajo births, the incidence rate was 14 times as high for hydrocephalus and 26 times as high for hip dysplasia as in 63,796 Japanese. Compared to a study of 43,711 American Indians, hydrocephalus was 6.1 times as high and hip dysplasia was 10 times as high among the Navajos.

From six extensive studies of major defects in Japanese and Caucasian births, Neel compared the racial frequency of six malformations readily diagnosed at birth: anencephaly, spina bifida, anophthalmos-microphthalmos, atresia ani, harelip/cleft palate and polydactyly.[23]

Compared to Neel's study of 63,796 Japanese births, the incidence rate for both atresia ani and polydactyly was approximately twice as high among 13,329 Navajos while anencephaly was twice as high among the Japanese. Compared to 43,711 American Indians, atresia ani was nearly three times as high among the Navajos as reported by Niswander et al.[24] for 43,711 American Indians. Otherwise, no great disparities exist for the frequency of these six major defects among Caucasians and Japanese in the rates of overall malformations. No anophthalmos-microphthalmos was ~~found in the medical records of~~ reported for the Navajo or American Indian populations sampled.

The apparent higher incidence of birth defects among the Navajo appears to relate in part to the continuing access to medical records in abstracting rather than to radiation exposure or ethnic genetic differences. In another study, between four and five times as many hospital records as birth certificates indicated that a congenital defect was observed at the time of delivery.[25]

III. Stillbirths and infant deaths under one year.

Stillbirths plus infant deaths under one year (most within 24 hours of birth) decreased, starting with a pronounced drop in 1974, totaling 15 compared to 42 for 1965 (Fig. 1). The lowest total occurred in 1980 and 1981 (12 each year: in 1980, 1 stillbirth, 11 infant deaths; in 1981, 6 stillbirths and 6 infant deaths).

Several factors may have contributed to this decline, as an increased number of Cesaerian deliveries in certain recent years (frequently ten percent of the total) or the maternal child health center developed on the Shiprock PHS/IHS hospital compound by the University of Utah.

Neel (1958) found that in 264 Japanese stillbirths without clinical diagnosis of major defect, 10.2 percent had internal defects of major proportions.[23] However, rare autopsies of stillbirths were performed in the Shiprock IHS hospital.

IV. Recurrence of index cases in certain families.

From a total of approximately 600 mothers selected for prospective interview, each of 39 women was a mother of two index cases, and each of four women was mother to three index children. The list which follows gives the incidence of one or more defective conditions in the 90 single index births to the 43 mothers.

Table 11.- Defective conditions and stillbirths among 90 infants born to 43 recurrent index mothers

21 stillborn
2 hydrocephalus
3 cortical cerebral atrophy
3 mental retardation
8 seizures, paralysis
7 harelip/cleft palate (two to same mother)
9 heart defects
6 respiratory distress or hyaline membrane disease
1 trisomy 21
3 other trisomies
3 polydactyly (2 to same mother)
7 hip dysplasia
2 lower arm bones deformed (both to same mother)
2 albinism

Table 11. Defective conditions and stillbirths among 90 infants born to 43 recurrent index mothers (continued)

In addition, a single case ~~each~~ occurred of each of 13 defects.

1 anencephaly	1 leukemia
1 microcephaly	1 thyroglossal cyst
1 head malformed	1 hyperthyroid
1 myelomeningocoele	1 hepatomegaly
1 spina bifida (in a stillbirth)	1 imperforate anus
1 sphaerocytosis	1 isoimmunization
1 osteoid osteoma	

In 43,546 American Indian single births, representing 95 tribal affiliations, more than one affected child was born to the same mother in only seven cases among 8,874 sibships or half-sibs (1975).[24] Two defective children were born to each of six mothers, and three were born to a seventh mother.

DISCUSSION

The present Navajo population of more than 210,000[26] are descended from the less than 10,000 relocated in the Four Corners area (1968) following the four-year impoundment at Fort Summer to end the Navajo raids. With a minimum admixture of Caucasian genes, certain tribal practices and traditions have contributed to maintaining the genetic integrity of the Navajo. Only Navajos are permitted to hold allotments or other title to tribal land. The Navajo system of land tenure plus the practice of marrying within the tribe tends to perpetuate the/geographic and genetic isolation. The habit of marrying outside the clan has tended to minimize inbreeding. Exposures were primarily chronic alpha to Navajo miners and low chronic gamma to their families compared to acute gamma and neutron exposures to the Japanese population. However, for Navajo miners, the alpha did not expose the gonads directly, but in limited amounts/during decay following depusition in bone.

irradiated the gonads

Gamma exposures did not approach permissible limits for Navajo miners (5,000 mR/yr) and at only a few locations of miner families reached the 25 mR/yr limit.

The high LET alpha radiation from radon decay is as much as 20-fold more effective in inducing changes in meiotic and post meiotic stages of cells compared to low LET radiation, for example, from gamma or x-rays.[27] At cumulative exposures of 100 WLM or less, the aberrations in peripheral lymphocytes cultured from uranium miners were increased two-fold. Cytogenetic effects, however, cannot be used to predict health effects. At present we have no sound basis for extrapolating from somatic cell end points to genetic effects.[28] A positive finding of untoward reproductive outcome cannot distinguish between the influence of teratogenic and mutagenic agents if both are present.

In Japan, 56,262 single births (1948-1954) to survivors of an estimated 10 gonadal rads of combined gamma ray and neutron exposures at Hiroshima and Nagasaki were examined at birth for four indicators of genetic effects of radiation.[29] These indicators were 1) frequency of untoward pregnancy outcomes (stillbirth, major congenital defect, death during the first postnatal week), 2) death to live-born children through an average life expectancy of 17 years, 3) frequency of children with sex chromosome aneuploidy, and 4) frequency of children with mutation resulting in an electrophoretic variant. In no instance was there a statistically significant effect of parental exposure; but for all indicators, the observed effect was in the direction suggested by the hypothesis that genetic damage resulted from the exposure.[29] The genetic doubling dose estimated for each of the first three indicators averaged 156 rems gonadal exposure. This is four times as high as the results from experimental studies on the mouse, suggesting that we are four times more resistant than mice to the genetic effect of radiation.[30] However, on a generation basis, mutation rates in mice are about the same as in ourselves. The data suggest that man has evolved rather sophisticated

repair enzymes to keep his genetic household in order.[30] Radiation has produced genetic effects in every single plant or animal that has been appropriately investigated.[30] Even a very large study, however, may be negative in the sense of not yielding "statistically significant" results.[28] This can create the presumption of no genetic effect where in fact one may exist. Present guidelines offer no cheap litmus paper which an anxious public and a harried government can dip into our gene pool and get an immediate answer.[28]

Like other investigations reported in the biologic and epidemiologic literature, the present observations on a segment of the Navajo population lend little support for adverse genetic outcome in man from radiation exposure.

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grant S06 RR08163 and 3) the Department of Family, Community and Emergency Medicine, University of New Mexico School of Medicine, Albuquerque. The authors acknowledge with appreciation the work of Dr. Cathy Hsi, University of New Mexico School of Medicine, for the analysis of data.

delete

prior to birth of infant

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Table 1. For 22 index miners, cumulative working level months of exposure, average WLM/year, mrem/yr and cumulative gonadal dose equivalents and infant defects

Code number	Relation to index	Social security #	Years mining	Working level months	Avg. WLM/ year	mrem/yr gonadal dose equivalents	cumulative gonadal exposure, mrem	cum gamma gonadal equiv from mine ore @ 275 mrem/yr	Total gonadal mrem equiv	Infant defects
A64017	father	728017937	4	134	34	from R&D 26	104	+ 1,100 =	1,204	diarrhea, death
A64048	father	722168614	10	252	25	38	380	+ 2,750 =	3,130	bilateral hip dysplasia
A65036	father	529426058	13	386	30	53	689	+ 3,575 =	4,264	R hip dysplasia
A68033	mat gfa	525464538	1							complete hemihypertrophy (head, chest, arms, legs)
A72019	mat gfa	525464538	6	2,082	347	337	2,022	+ 1,650 =	3,672	osteogenesis imperfecta, mental retardation, limb anomalies, ear deformity
A70036	father	525761785	6	314	52	46	276	+ 1,650 =	1,926	mental, motor retardation, seizures, spastic hemiplegia, club feet, L hip dysplasia, anencephalopathy, at age 11 could not sit or walk
A70037	father	525425486	14	1,394	100	208	2,912	+ 3,850 =	6,762	R cleft lip, bilaterally cleft palate
A73005	mat gfa	525407660	2	939	469	133	266	+ 550 =	816	hydrocephaly, mediastinal mass, CSF protein, infant death
A73008	father	525340896	13	372	29	51	663	+ 3,575 =	4,238	infant death, pneumonia
A73022	father	525425517	6	568	95	77	462	+ 2,772 =	3,234	hemiplegia, epilepsy, skull-face anomaly, motor retardation
A73023	father	525785900	11	874	80	123	1,353	+ 3,025 =	4,378	hip dysplasia
A73035	pat gfa	529325608	2	50	25	18	36	550 =	586	developmental delay, motor retardation
A74010	mat gfa	726161571	2	196	98	32	64	+ 550 =	614	ptosis L eye, tibial torsion, internal bowing
A74033	father	725014617	5	1,795	359	281	1,405	+ 1,375 =	2,780	Down's syndrome (mo age 42), respiratory distress syndrome
			94	9,355	1,743	1,423	10,632	26,972	37,604	

Table 1. (continued)

Code number	Name, miner (delete)	Relation to index	Social security #	Years mining (prior to birth of infant)	Working level months	Avg. WLM/ year	mrem/yr gonadal dose equivalents	cumulative gonadal exposure, mrem	cum gamma gonadal equiv from mine ore @ 275 mrem/yr	Total gonadal mrem equiv	Infant defects
A76003		father	521424563	13	728	56	101 (from 210)	1,313	+ 3,575 =	4,888	respiratory distress syndrome
A76010		father	525703258	3	809	270	113	339	+ 825 =	1,164	congenital debility
A76011		father	523387983	11	1,162	106	168	1,848	+ 3,025 =	4,873	hemiplegia, coordination disorder, cerebral palsy
A77019		pat gfa	527247582	10	303	30	44	440	+ 2,750 =	3,190	congenital heart disease, VSD, ASD
A79020		pat gfa	525342949	8	976	122	139	1,112	+ 2,200 =	3,312	leukemia, expired
A79029		pat gfa	525343686	13	2,223	171	364	4,732	+ 3,575 =	8,307	stillborn
A80002		father	728019231	10	2,493	249	418	4,180	+ 2,750 =	6,930	Down's syndrome (mother age 42)
A80003		ie pat gfa	523324294	8	296	37	44	352	+ 2,200 =	2,552	expired, congenital heart disease, DiGeorge syndrome
A81016		father	722014583	6	1.7	0.3	16	96	+ 1,650 =	1,746	aganglionosis, large, small bowel; partial albinism, bilateral clinodactyly
				82	8,991.7	1,041.3	1,407	14,412	22,550	36,962	
				+ 94	+9,355	+1,743	+1,423	+10,632	+26,972	+37,604	
				176	18,347 div by 22 = 834	2,784 div by 22 = 127	2.830 div by 22 = 129	25,044 div by 22 = 1138	49,522 div by 22 = 2251	74,566 div by 22 = 3389	

Table 1. For 14 control miners, cumulative working level months of exposure, average WLM/yr, mrem/yr and cumulative gonadal dose equivalents

Code number	Name, miner	Relation to control	Social security #	Years mining	Working level months	Avg. WLM/ year	mrem/yr gonadal dose equivalents	cumulative gonadal exposure, mrem	cum gamma gonadal equiv from mine ore @ 275 mrem/yr	Total gonadal mrem equiv	Infant defects
C64002		father	722118126	14	194	14	32	448 +	3850 =	4,298	none
C64042		father	728019521	7	913	130	129	903 +	1,925 =	2,828	none
C64049		father	525486233	9	396	44	55	495 +	2,475 =	2,970	none
C65030		son father	728093639	4	612	153	83	332 +	1,100 =	1,432	none
C69007		father	728093639	"	"	"	"				none
C67021		father	723141039	13	1,820	140	287	3,731 +	3,575 =	7,306	none
C69024		as father	722168235	10	510	51	69	690 +	2,750 =	3,440	none
C69030		father	728018789	14	945	68	135	1,890 +	3,850 =	5,740	none
C70022		father	725144698	11	464	42	63	693 +	3,025 =	3,718	none
C71023		pat gfa	529407104	2	118	59	24	48 +	550 =	598	none
C71036		father	728018165	3	100	33	22	66 +	825 =	891	none
C72021		father	525407021	2	118	59	24	48 +	550 =	598	none
C76025		mat gfa	525349525	2	174	87	30	60 +	550 =	610	none
C78007		father	728019543	2	72	36	20	40 +	550 =	590	none
C81002		mat gfa	525260338	7	909	129	129	903 +	1,925 =	2,828	none
				100	7,345 div by 14= 525	1,045 div 14 = 75	1,102 div by 14 = 79	10,347 div by 14 = 739	27,500 div by 14 = 1964	37,847 div by 14 = 2703	